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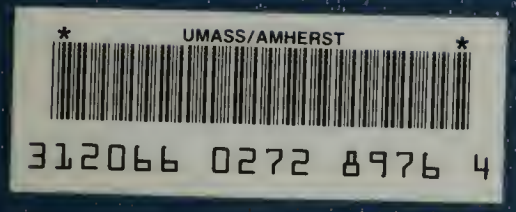

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COMMONWEALTH OF MASSACHUSETTS
SUMMARY OF WATER QUALITY
1990

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner
Arleen O'Donnell, Assistant Commissioner

DIVISION of WATER POLLUTION CONTROL

Brian M. Donahoe, Deputy Director

PUBLICATION #16,358-96-25-6-90-C,R,
APPROVED BY: RIC MURPHY, PURCHASING AGENT

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COMMONWEALTH OF MASSACHUSETTS

SUMMARY OF WATER QUALITY

1990

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER POLLUTION CONTROL
TECHNICAL SERVICES BRANCH
WESTBOROUGH, MASSACHUSETTS

Executive Office of Environmental Affairs
John P. DeVillars, Secretary

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner
Arleen O'Donnell, Assistant Commissioner

Division of Water Pollution Control
Brian M. Donahoe, Deputy Director

June 1990

TITLE: Summary of Water Quality 1990

DATE: May 1990

REVIEWED BY:

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Department of Fisheries, Wildlife and Environmental Law Enforcement

- Division of Fisheries and Wildlife
- Division of Marine Fisheries

Department of Public Health

- Division of Epidemiology and Toxicology

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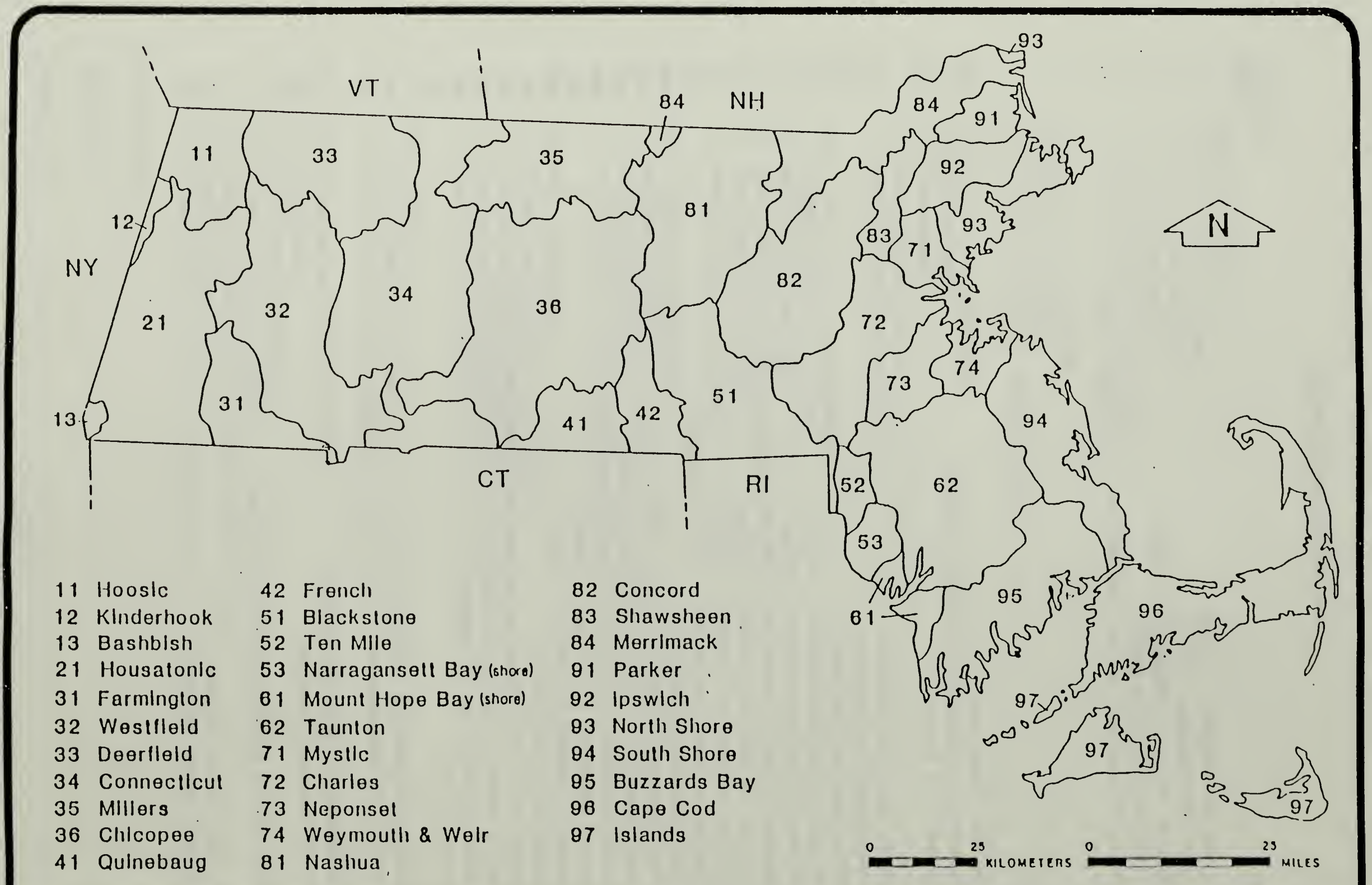


11	Hoosic	42	French	82	Concord
12	Kinderhook	51	Blackstone	83	Shawsheen
13	Bashbish	52	Ten Mile	84	Merrimack
21	Housatonic	53	Narragansett Bay (shore)	91	Parker
31	Farmington	61	Mount Hope Bay (shore)	92	Ipswich
32	Westfield	62	Taunton	93	North Shore
33	Deerfield	71	Mystic	94	South Shore
34	Connecticut	72	Charles	95	Buzzards Bay
35	Millers	73	Neponset	96	Cape Cod
36	Chicopee	74	Weymouth & Weir	97	Islands
41	Quinebaug	81	Nashua		

Figure **A**

COMMONWEALTH OF MASSACHUSETTS
RIVER BASINS and COASTAL DRAINAGE AREAS

1.0 EXECUTIVE SUMMARY

1.1 The 305(b) Process

The Federal Clean Water Act (CWA) establishes a process for the development of information concerning the quality of the Nation's waters and reporting this information to the Environmental Protection Agency (EPA) and the U.S. Congress. Each state must develop a program to monitor the quality of its surface and ground water and prepare a report every two years describing the status of water quality. This process, referred to as the 305(b) process, is the principal means by which the EPA, Congress, and the public evaluate water quality, the progress made in maintaining and restoring water quality, and the extent to which problems remain.

In 1988, EPA began the implementation of an automated data management to record the results of water quality assessments and manage newly-required assessment information under the Water Quality Act of 1987. The Section 305(b) Waterbody System (WBS) is under implementation in Massachusetts and attempts to improve consistency in guidance for determining use support, determining total state waters and assessing trends. The effort to implement these new guidelines makes this year's report incomparable with previous year's reports but provides a common basis for future assessment with other states.

Under the January 12, 1989 proposal to amend the Water Quality Management Regulation (40 CFR Part 130), the Section 305(b) reporting process will become the long-term vehicle for WQA reporting on lakes, nonpoint source pollution, and toxics in surface waters.

1.2 River Assessment

Approximately 80% of the over 8,000 river miles in the Commonwealth are unpolluted and are not included in this assessment. These waters consist mostly of small headwater streams. The assessed waters include only 20% of the river miles, but consist of all the principal main stem rivers and therefore the larger proportion of the stream flow.

Assessed rivers break down nearly evenly into thirds for support, partial support and nonsupport of designated uses (Figure 1.1A). This is comparable with the rivers support status ten years ago. However, the analysis shows that the pollution load to these rivers has been greatly reduced over the past ten years. Pollutants such biochemical oxygen demand and nutrients have been reduced by about one half. Ammonia and suspended solids have been virtually eliminated as causes of non attainment (Figure 1.1B). This improvement is largely due to the joint federal and state Construction Grants Program that has distributed over 2.5 billion dollars in sewage treatment grants to Massachusetts municipalities since 1967. One hundred thirty-nine (139) publicly owned treatment works (POTW's) are permitted under the National Pollutant Discharge Elimination System (NPDES) which collect and treat over one billion gallons of sanitary and industrial wastewater each day and serve over 70% of the state's population. Due to this effort municipal and industrial point sources have been significantly reduced as sources of non attainment (Figure 1.1C).

Over 65% of the rivers assessed now meet the fishable goal and 42% meet the swimmable goal (Figure 1.4A). The major benefit of pollution control efforts has been the increase in waters meeting the fishable goal. The swimming goal continues to not be met because of the overlapping effects of nonpoint source pollution. This also prevents most waters from meeting their designated uses, for nearly all surface waters in Massachusetts are designated for both fishing and swimming. The most prominent source of non attainment in rivers is urban runoff. The percentage of river miles adversely impacted remains the same as 1979 (approximately 40%). The cause of non attainment that is detected by the monitoring program is pathogen indicators (high bacterial counts). This parameter has not undergone the substantial reduction of other pollutants. Both the cause and the source may be over simplifications of the problem. "Urban runoff" may, on closer inspection, include broken and leaking sanitary sewers, small illicit discharges of waste, periodic dumps or spills or other similar activities. Increased monitoring may reveal metals, organics and oil and grease in sediments in addition to the pathogen indicators already detected. Nonpoint source management planning and stormwater permitting efforts have been intensified during the past year in order to better address these problems.

About 20% of the rivers assessed (4% of the total river miles in the state) exhibit high levels of toxic pollutants (Figure 1.5A). The pollutants consist mostly of metals and priority organics in the sediments and fish flesh (Figure 1.5B and C). Six major fishing advisories account for half of the problem. With few exceptions, the pollution appears to be from a history of prior pollution and not from active discharges of these pollutants. Abatement measures for in-place sediments need to be developed.

1.3 Lakes Assessment

Over 40% of the lake and pond acres in the state are assessed in this year's report, but 40% of these acres belong to one waterbody: Quabbin Reservoir. The inclusion of this waterbody heavily skewed the results of the entire assessment. Elevated levels of mercury in fish flesh has resulted in a fishing advisory on the reservoir and an assessment of nonsupport. This is responsible for all but 1.6% of the nonsupport acres in the assessment, and for all of the metals category in the causes of non attainment (Figure 1.2A and B). Over 70% of the lakes assessed meet the swimmable goal and, with the exception of Quabbin Reservoir, 96.6% of the acres assessed meet the fishable goal. Major causes of non attainment include nutrients and excessive aquatic plant growths. The major sources of these problems are unknown but believed to be various nonpoint sources.

1.4 Marine Water Assessment

Marine waters receive 75% of the total daily discharge of municipal wastewater in the Commonwealth (primarily in Boston Harbor). The cleanup of these sources has lagged behind the cleanup of rivers. The assessment shows that nearly 75% of the marine waters assessed do not support their designated uses. This is primarily due to municipal point sources and Combined Sewer Overflows (CSO's) contributing to the bacterial contamination of these waters (Figure 1.3C). However, nonpoint source pollution is perceived as a significant problem, although not fully assessed at this time. Information from unassessed waters indicates a disturbing downward trend in water quality in

marine waters. This is most likely due to the rapid development of shoreline areas during the eighties.

Although only 13.2% of the waters assessed supported their designated uses nearly 40% supported the swimmable goal and nearly 60% supported the fishable goal (Figure 1.4C). Since the marine monitoring program has concentrated on documenting contaminated areas, it can be assumed that more representative sampling would reveal even high percentages meeting the CWA goals.

1.5 Toxic Pollutant Assessment

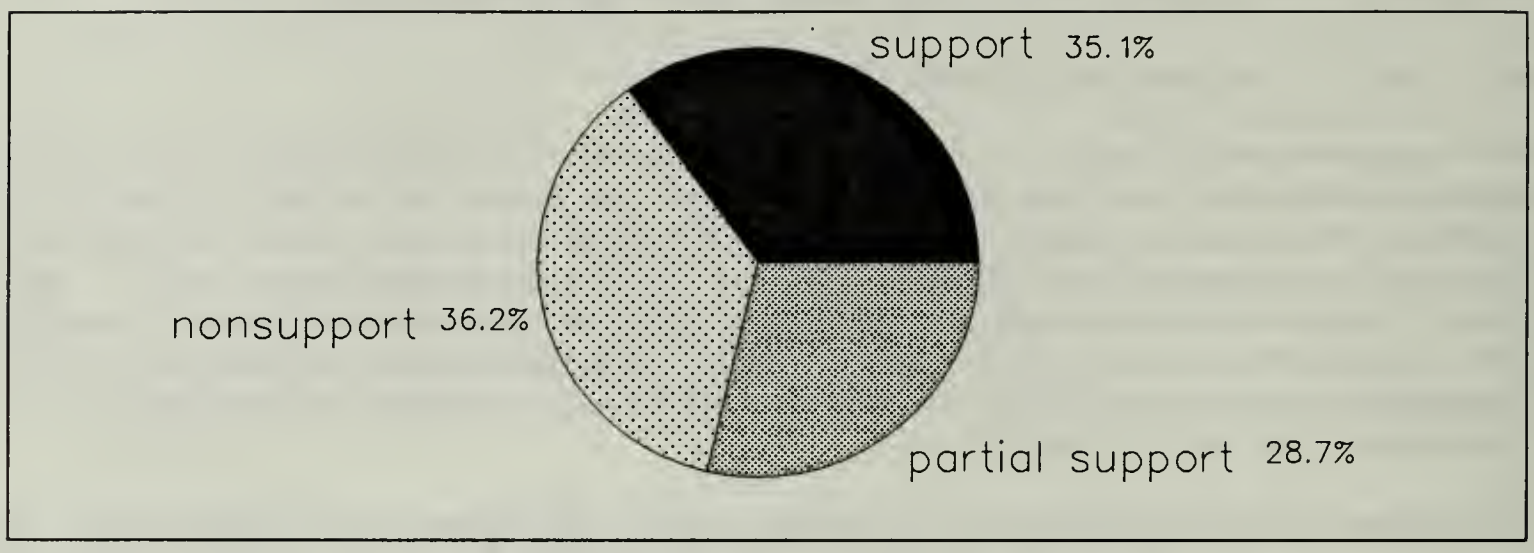
Although the assessment of toxic pollutants in the Commonwealth has progressed with new sampling techniques and analytical methods, it is by no means considered complete or comprehensive. The current analysis shows the highest percentage of contamination occurring in marine waters (Figure 1.5A). River waters show a lower percentage of contamination (20% of the waters assessed) than the other two waterbody types. The Lakes assessment is due entirely to contamination of fish flesh in Quabbin Reservoir. Other lakes remain unassessed for toxic pollution.

The causes of nonsupport are a mixture of metals, priority organics and other toxic pollutants. These contaminants are usually detected in the sediments or biota and not in the water column. Marine waters were the only waterbody type showing significant water column contamination. This was primarily due to ammonia in Boston Harbor. The state is making major revisions to its water quality standards in order to better address toxic pollutants.

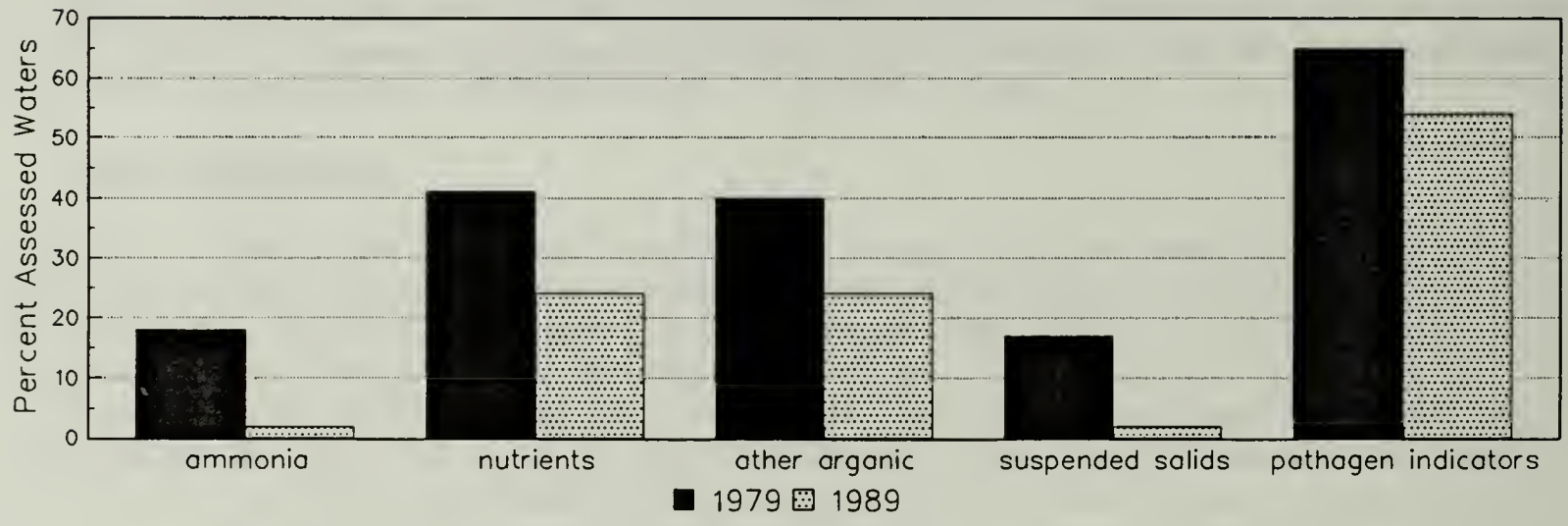
Figure 1.1

RIVER ASSESSMENT – 1989

A. Designated Use Support



B. Causes of Non Attainment



C. Sources of Non Attainment

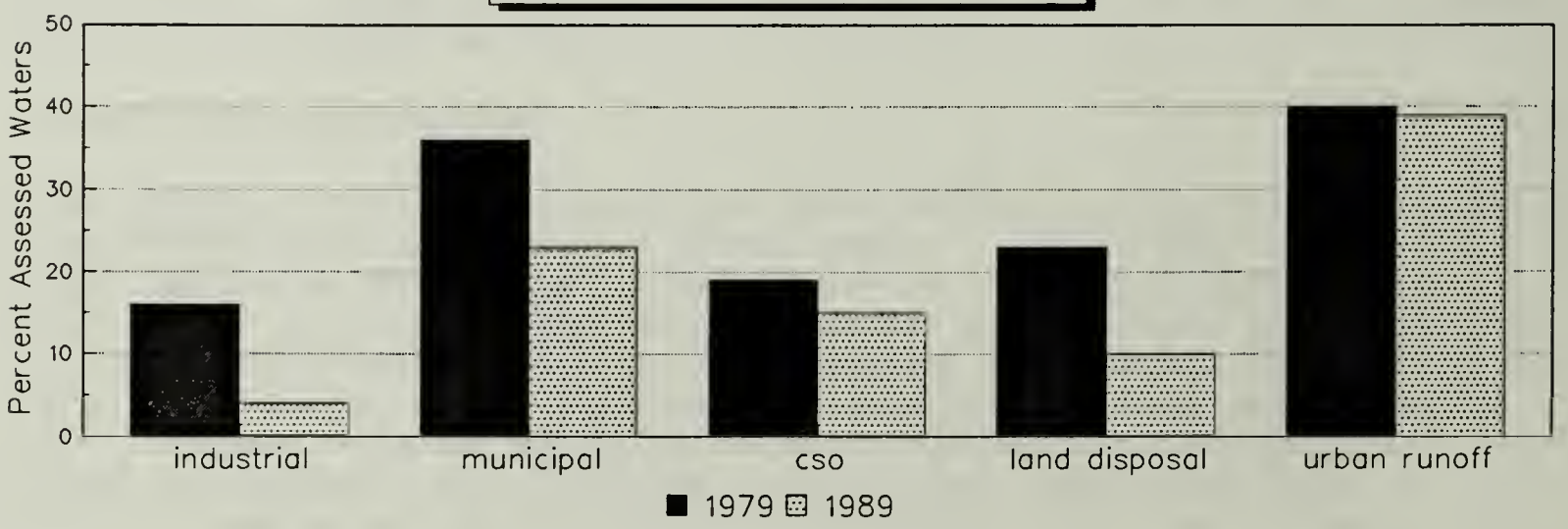
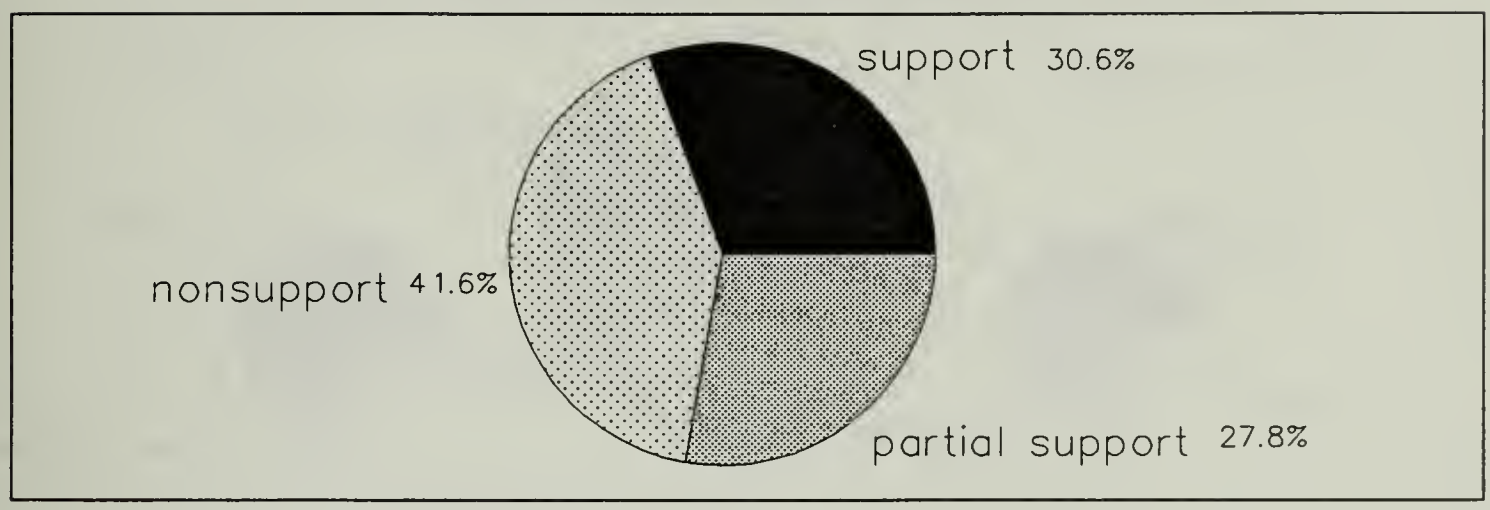


Figure 1.2

LAKES ASSESSMENT – 1989

A. Designated Use Support



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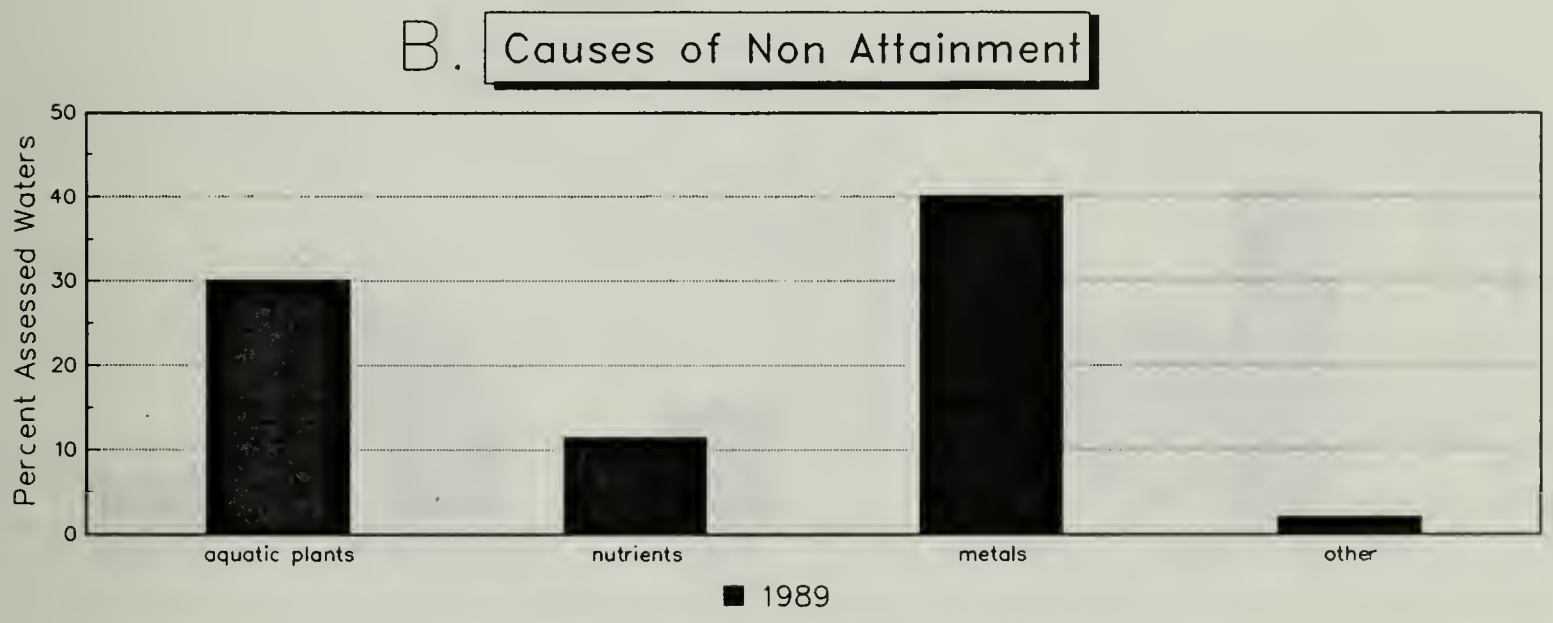

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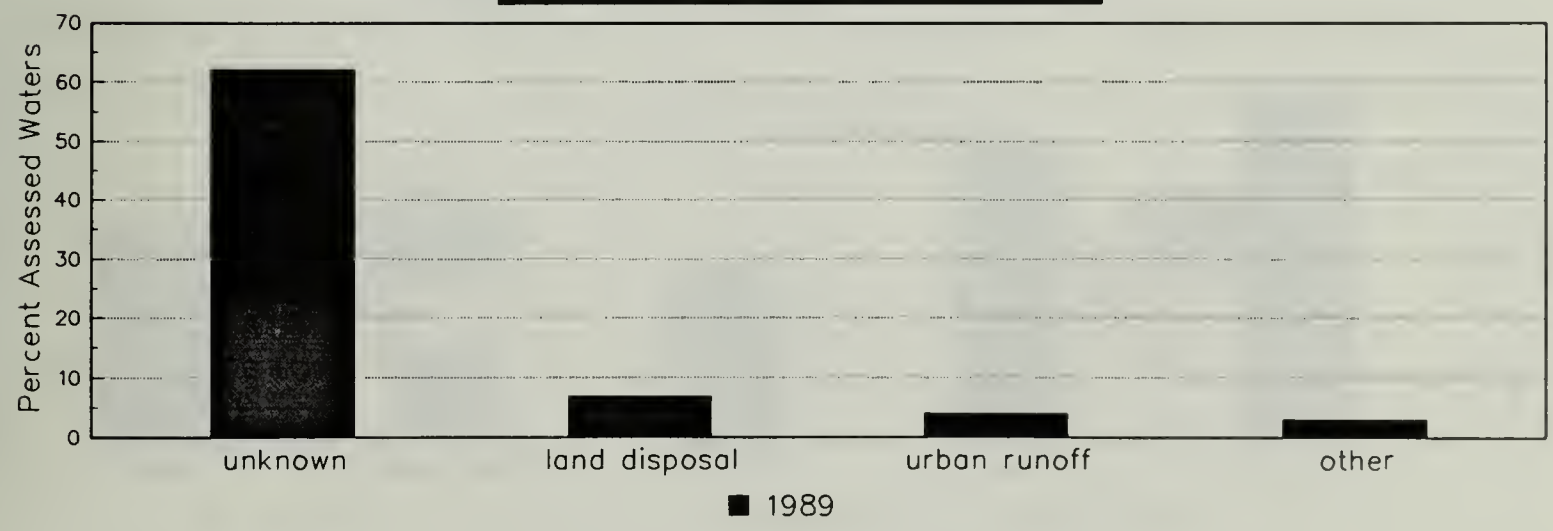
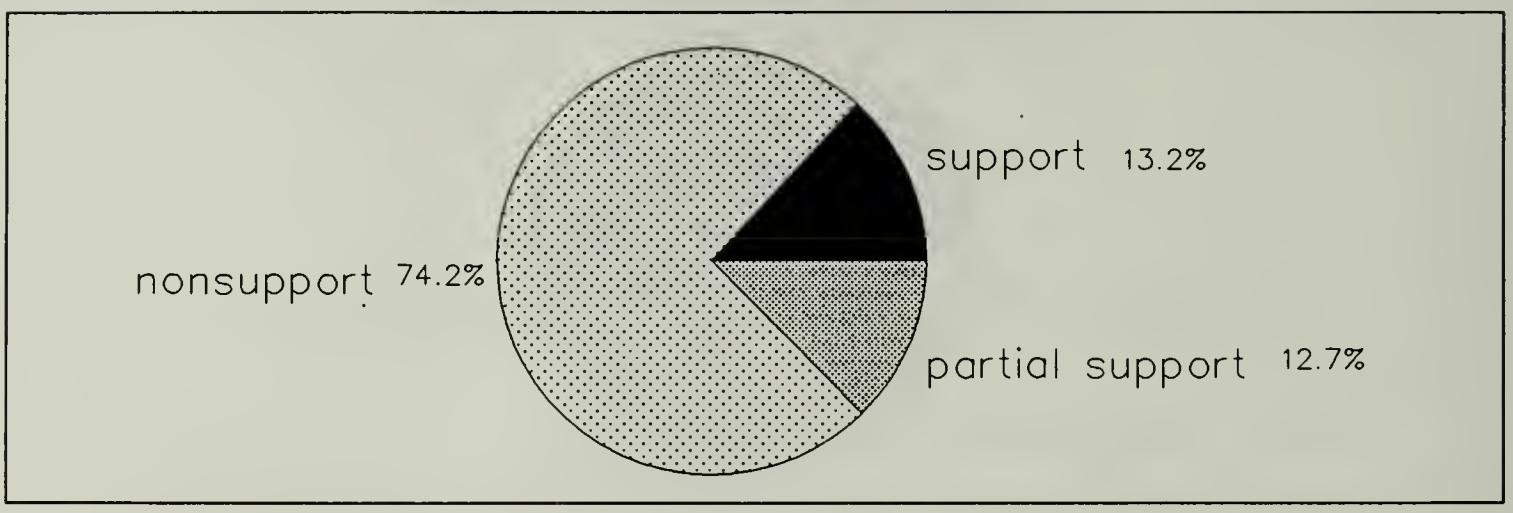


Figure 1.3

MARINE WATERS ASSESSMENT – 1989

A. Designated Use Support



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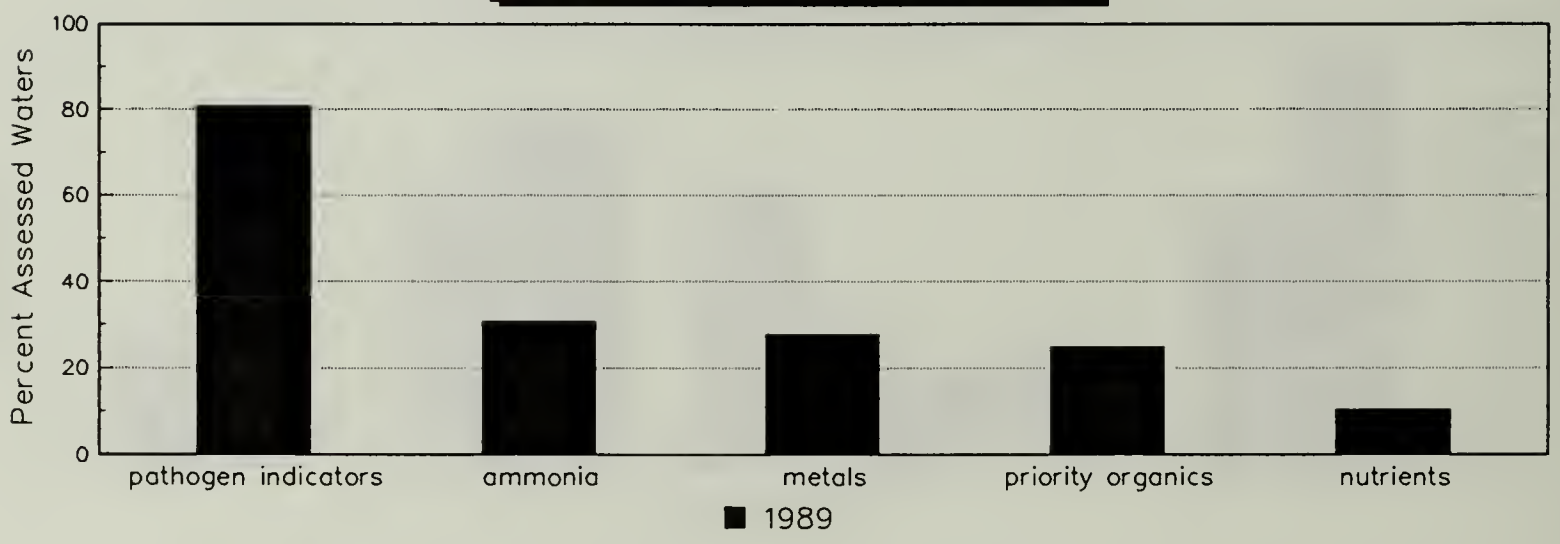

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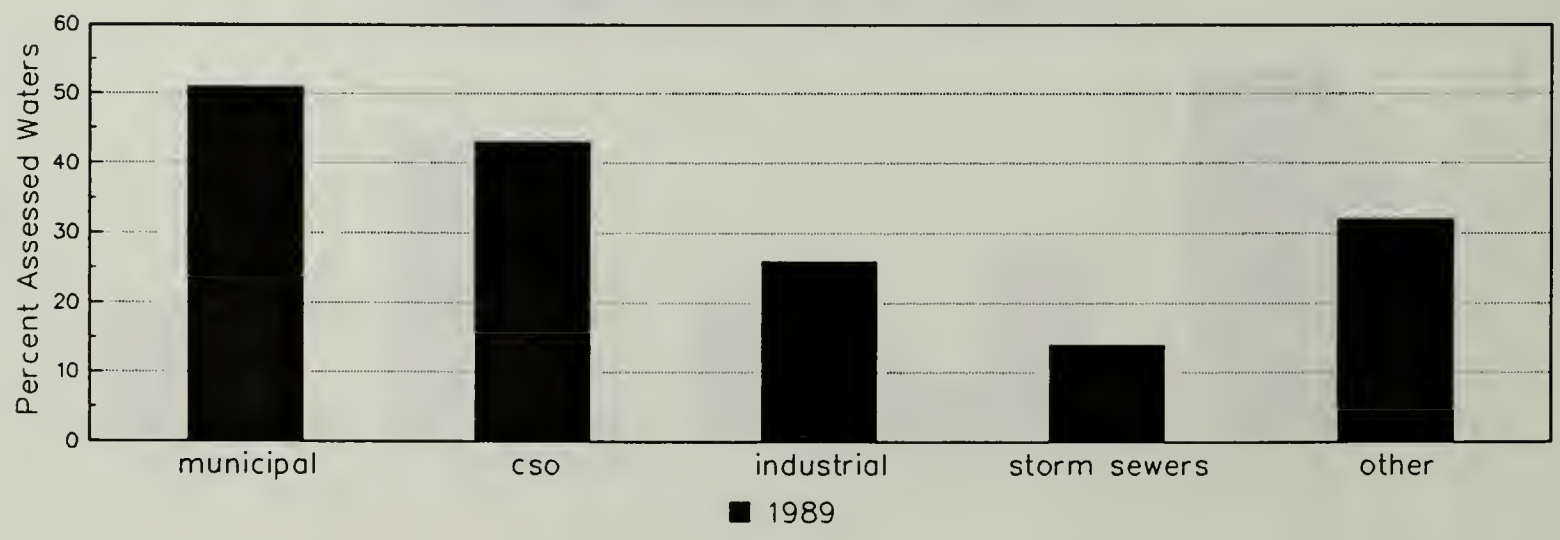
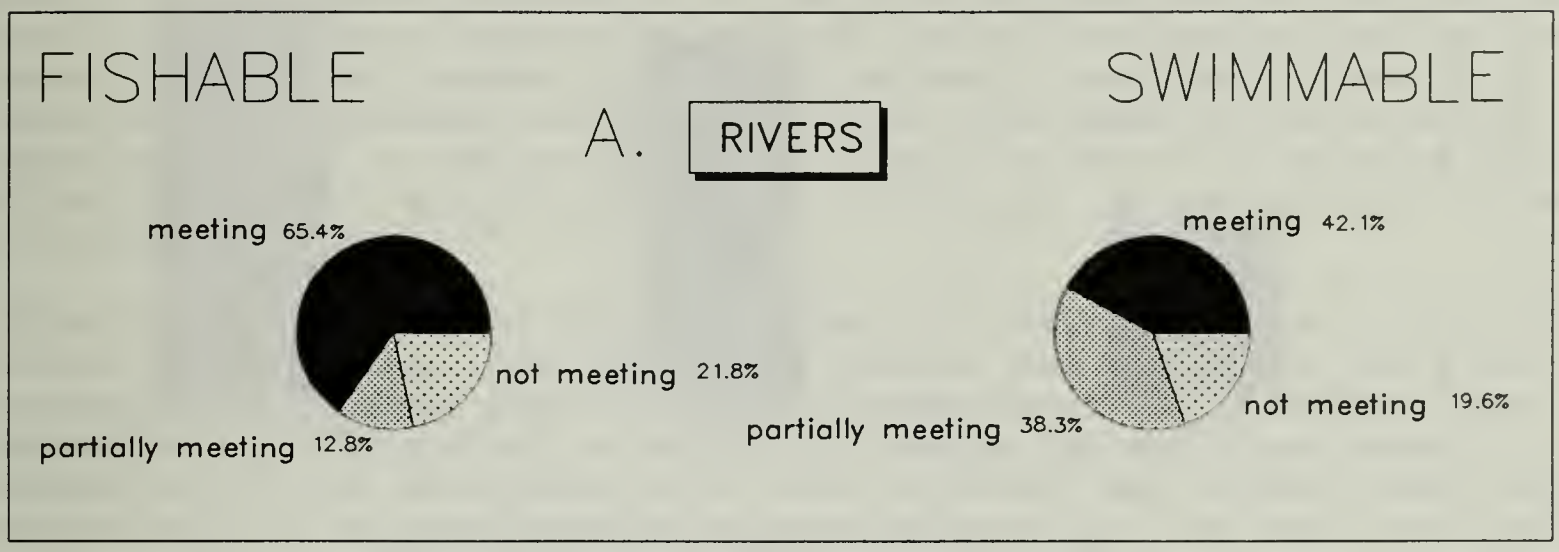
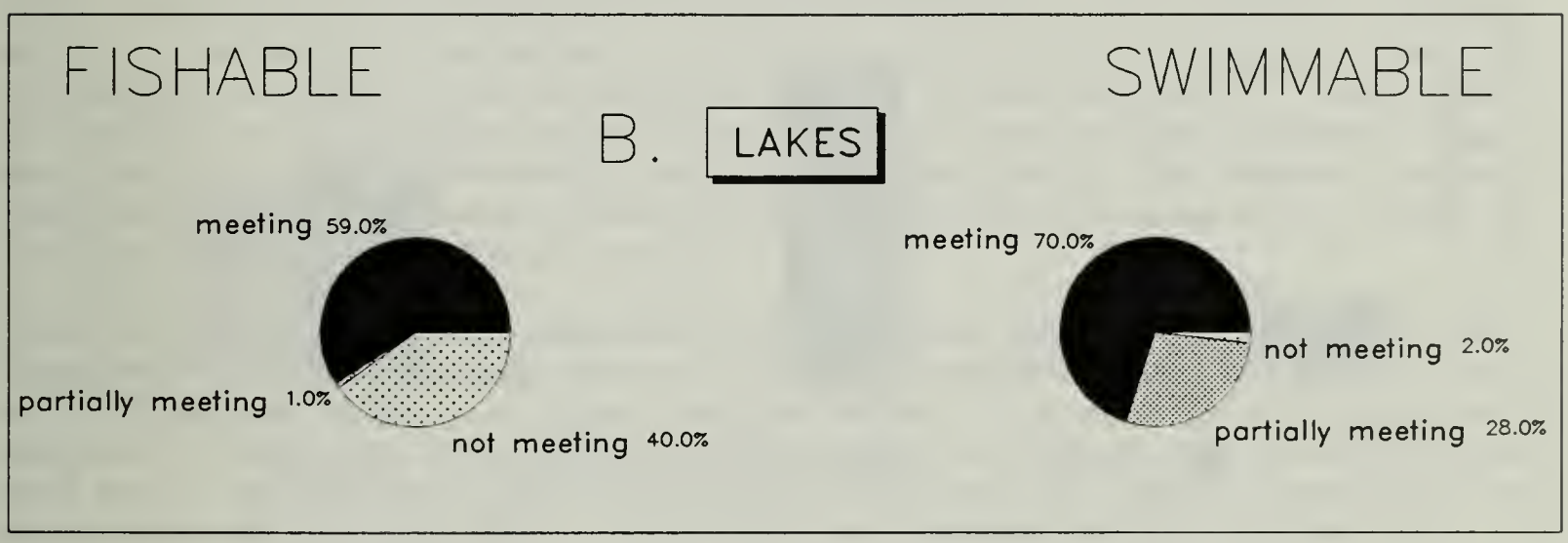


Figure 1.4

ATTAINMENT OF CWA GOALS
1989





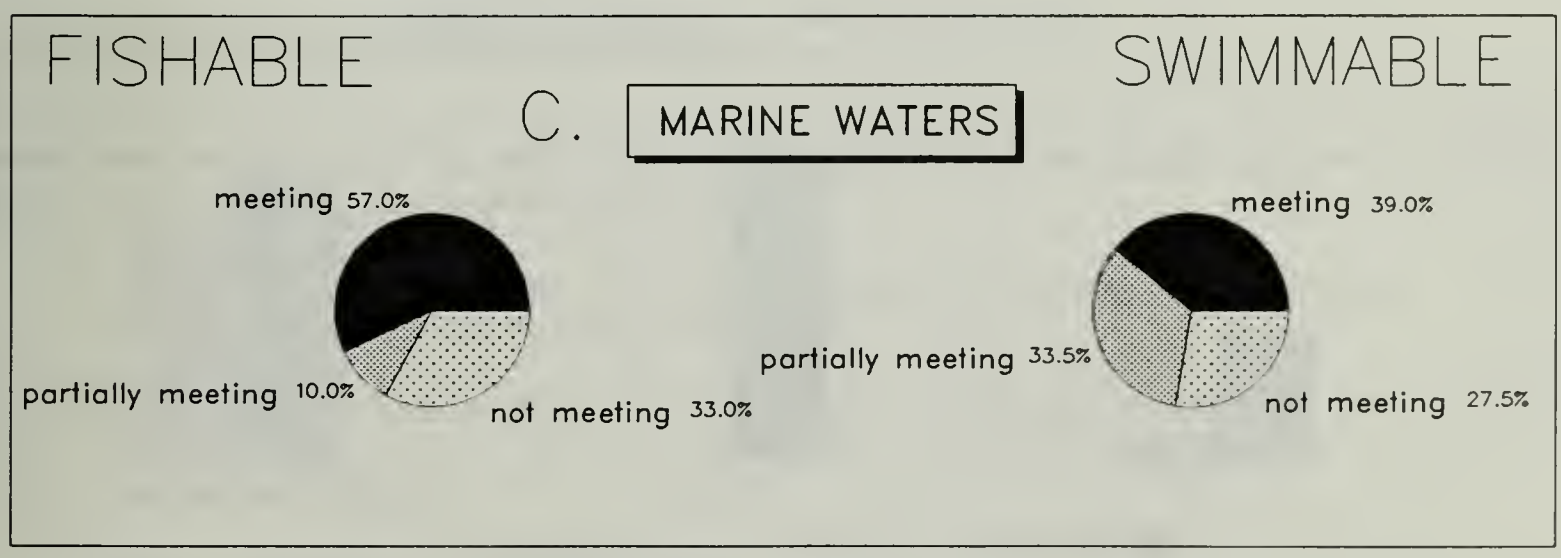
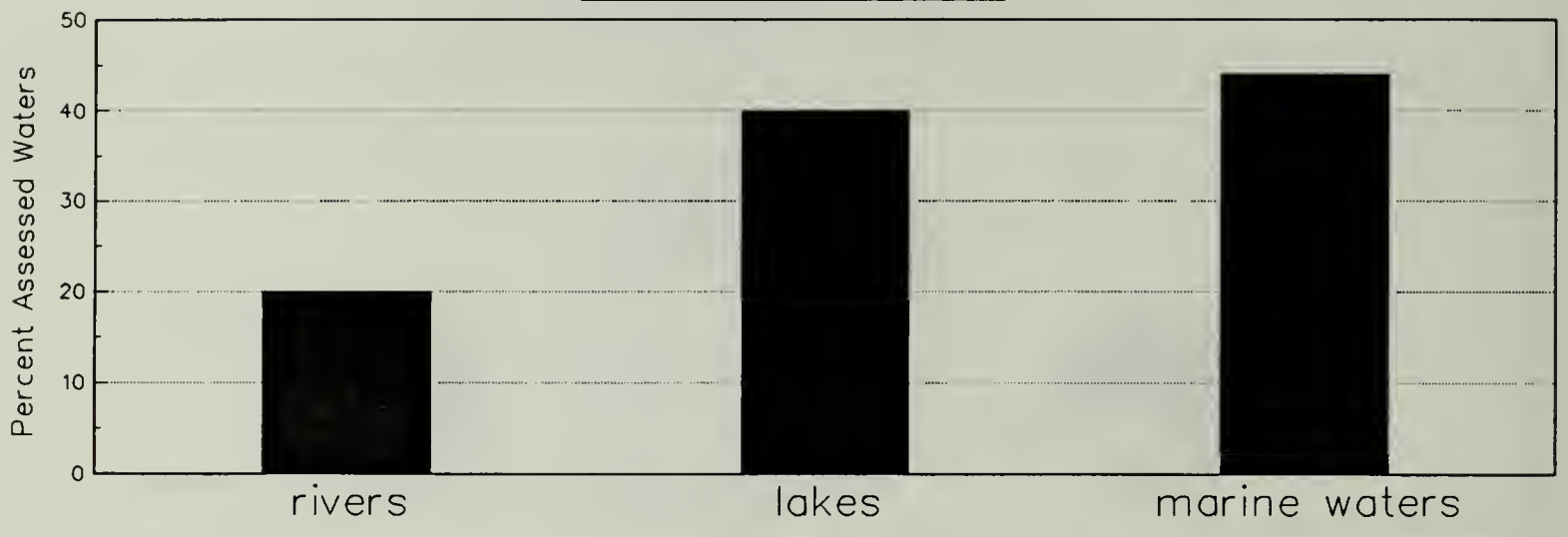


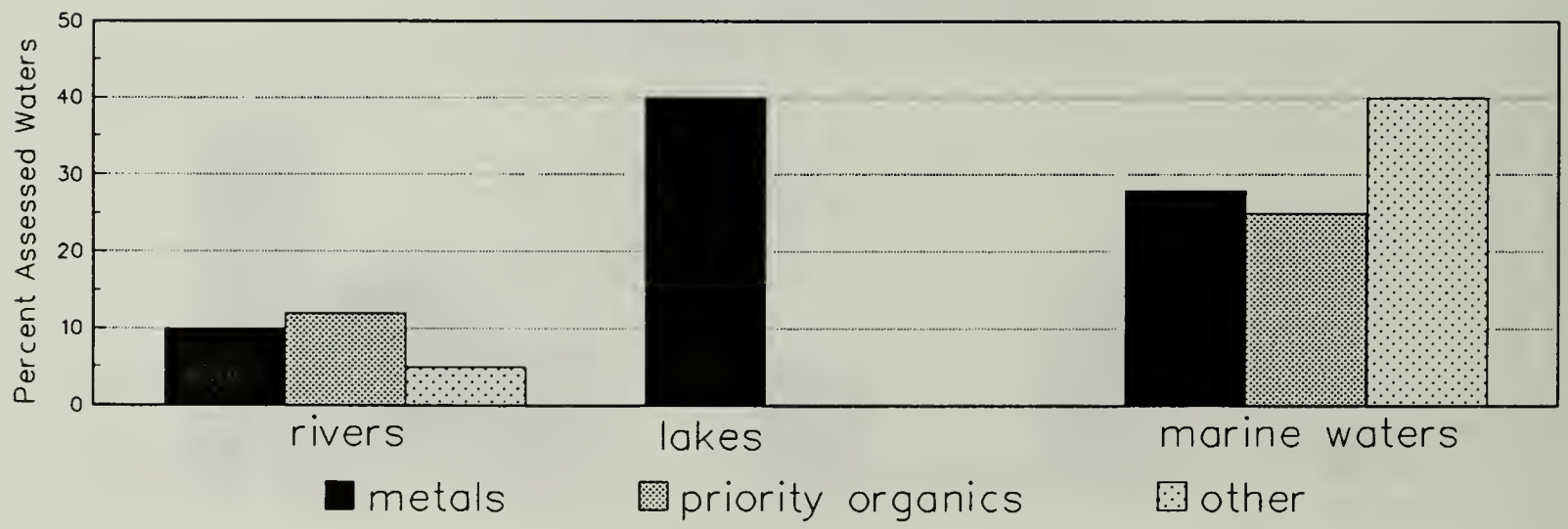
Figure 1.5

TOXIC ASSESSMENT IN SURFACE WATERS

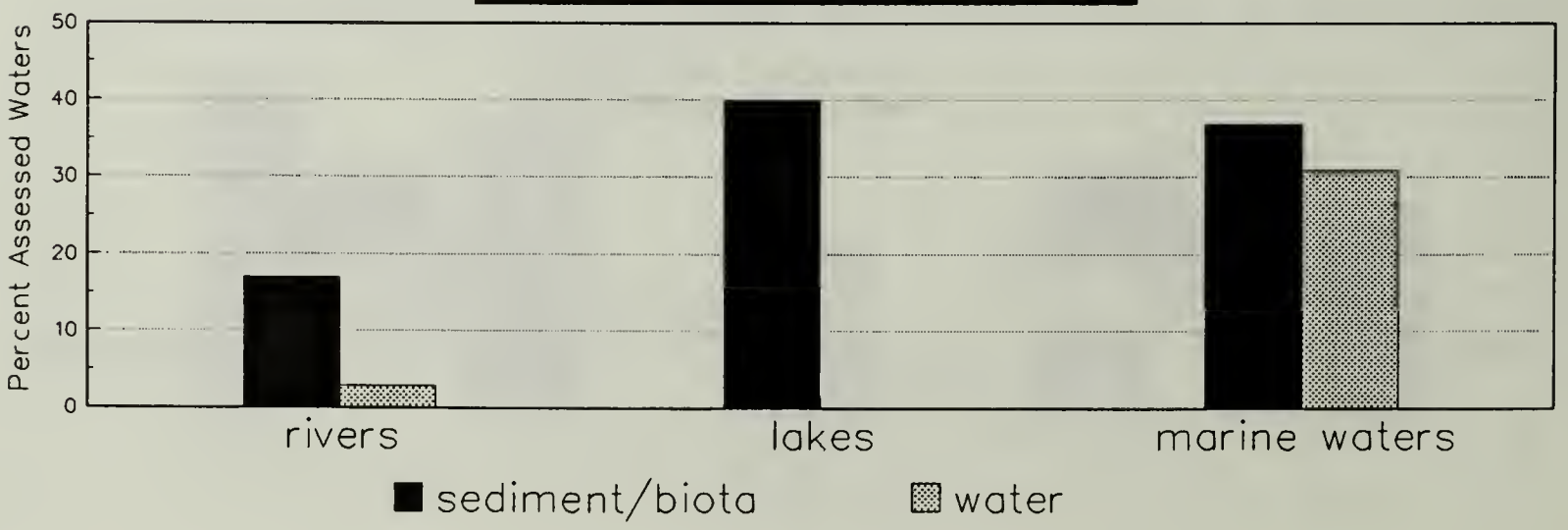
A. ELEVATED TOXICS 1989



B. Causes of Non Attainment



C. Environmental Compartments



2.0 BACKGROUND INFORMATION

2.1 Water Resources[1]

The Commonwealth of Massachusetts has the largest population of the six New England States with nearly six million people. More then 75 percent of the population resides in the eastern one-third of the state. Precipitation averages about 45 inches per year and is fairly evenly distributed through the state. Average annual evaporation of free water surfaces ranges from about 26 inches in Western Massachusetts to about 28 inches in the eastern half of the State. Yearly runoff ranges from about 20 inches in Cape Cod to about 32 inches in the northwestern corner of the State. The lowest runoff generally occurs during July, August and September. Runoff is highest in March in the eastern sections of the state and highest in April in the western sections and at higher elevations.

The geology of the state is divided into two provinces: the Coastal Plain and the New England Upland. Cape Cod and the Islands form the coastal plain and consist of low hills and plains covering unconsolidated sediments which form the most productive aquifers in the State. The New England Upland province consists of till and stratified drift above metaphoric and igneous rocks, and provides small productive aquifers. Ground water is used for water supply in small communities and almost exclusively on Cape Cod and the Islands. Surface water is the major source of supply for all the major urban areas of the state, because no other source is capable of meeting these demands. Surface water in the state is relatively plentiful, and of high quality, but not distributed in proportion to the distribution of the population. Two thirds of the people in the State depend upon surface water for their needs. The Metropolitan District Commission supplies communities in the Greater Boston area (about half the state usage of surface water) from reservoirs in the Chicopee and Merrimack River Basins.

Offstream water use is estimated at 2,500 million gallons per day (MGD) of freshwater withdrawals from surface and ground water. Nearly 85 percent of this is surface water. Of these surface waters 71 percent is industrial self-supplied withdrawals (1,500 MGD) and 29 percent is public supply withdrawals (610 MGD). Agricultural uses (irrigation and livestock supply) comprise less than 1 percent of this total. In-stream use for hydroelectric power is estimated at 25,000 MGD.

2.2 Classification of Surface Waters

The Massachusetts Surface Water Quality Standards (314 CMR 4.00) define six water use classes for surface waters. The three fresh water classes and three salt water classes are summarized below:

Class A - Public Water Supply, fishable/swimmable to the extent compatible with this use.

Class B - Fishable/swimmable and other compatible uses.

---

[1] Source: Gadoury and Wandle (1986).

TABLE 2.1

SURFACE WATER ATLAS

General[1]

State Population (1988)	5,890,000
State Surface Area (Land) mi^2	7,824
State Surface Area (Water) mi^2	460

Rivers[2]

Major Drainage Systems	9
Number of Sub-Basins	32
Interstate Sub-Basins	12
Total River Miles	8,053
Number of Named Streams	2,002
Miles of Named Streams	5,460

Lakes[3]

Number of Lakes and Ponds	2,871
Area of Lakes and Ponds (acres)	151,173

Coastal Waters[4]

Area of Harbors and Estuaries (mi^2)	177
Total Coastal Miles	1,519

Wetlands[5]

Total Area of Wetlands (acres)	588,486
Marine and Estuarine Wetlands (acres)	118,000
Freshwater Wetlands (acres)	470,486

Sources:

1 M.I.S.E.R. 1990
2 Halliwell, et. al., 1982 and River Miles 1990
3 Ackerman, 1989
4 Gil, 1985 and Maietta, 1984
5 Tiner, 1989

Class C - Fishable, but not swimmable.

Class SA - Fishable/swimmable plus open shellfishing.

Class SB - Fishable/swimmable plus restricted shellfishing.

Class SC - Fishable, but not swimmable.

Waters must be classified B (or SB) or better in order to comply with the national fishable/swimmable goal. The fishable Clean Water Act (CWA) goal is defined as protection and propagation of fish, shellfish and other aquatic life and wildlife. The swimmable CWA goal is defined as providing for recreation in and on the water.

Certain waters are designated for special protection under the antidegradation provisions of the regulation. These restrict or prohibit wastewater discharges to low flow waters, high quality waters and outstanding resource waters. Inland waters are subcategorized as to fishery type - cold water fishery, seasonal cold water fishery, warm water fishery and aquatic life - based upon the waterbody's natural potential to support these uses. These subcategories determine the specific dissolved oxygen and temperature criteria to be applied to the waters.

The standards contain tables and maps that list and classify the more prominent waters of the State. Waters not specifically listed in the regulations are Classified B for fresh waters and SA for salt waters. All surface waters are therefore classified including, without limitation, rivers, streams, lakes, ponds, springs, impoundments, estuaries, wetlands and coastal waters.

Separate regulations (314 CMR 6.00) classify ground waters.

Table 2.2 summarizes the entire state in relation to the national goal and Table 2.3 lists waters classified below the national goal.

TABLE 2.2

SUMMARY OF CLASSIFIED SURFACE WATERS

TYPE OF WATER	TOTAL WATERS CLASSIFIED	WATERS CLASSIFIED FOR USES CONSISTENT WITH CWA GOALS		TOTAL WATERS UNCLASSIFIED
		FISHABLE	SWIMMABLE	
River (miles)	8,053	8,053	8,034.1	(O)
Lakes (acres)	151,173	151,173	151,173	(O)
Harbors & Estuaries (mi^2)	177	177	174.7	(O)

TABLE 2.3

CLASS C/SC WATERS

SEGMENT	CLASS	SIZE
	Charles River Basin	
Charles River Basin from Watertown Dam to Science Park Dam	C	8.6 miles
Charles River Basin from Science Park Dam to Boston Inner Harbor	SC	1.2 miles
Muddy River, entire length	C	2.7 miles
Back Bay Fens	C	1.5 miles
	Mystic River Basin	
Mystic River from Amelia Earhart Dam to confluence with the Chelsea River	SC	2.0 miles
Chelsea River, entire length	SC	2.4 miles
Island End River, entire length	SC	0.5 miles
	Boston Harbor	
Boston Inner Harbor westerly inside a line from the southern tip of Governor's Island to Fort Independence	SC	2.3 sq. miles

---

* Total miles 18.9, total square miles 2.3

3.0 SURFACE WATER ASSESSMENT

3.1 Methodology

The Division of Water Pollution Control drew from an extensive data base in order to assess the surface waters of the Commonwealth. During the past 27 years the Division has collected water quality information at over 3,000 locations in the state and published 509 scientific and technical reports comprising over 38,000 pages of water quality analyses. In addition, the Division has conducted over 100 separate biological studies on macro-invertebrates, fish, bacteria and other aquatic communities.

In addition to its own data base the Division used information supplied by the following sources:

State Agencies

Division of Marine Fisheries
Division of Fisheries and Wildlife
Division of Water Supply
Division of Wetlands and Waterways

Federal Agencies

U.S. Geological Survey
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Private Consulting Firms

Various Facilities Plans
Massachusetts Clean Lakes Program 628 projects (70 lakes)
Service Contract for Toxicity Testing

Scientific Organizations

Woods Hole Oceanographic Institute
Water Resources Research Center
Massachusetts Institute for Social and Economic Research
Boston Harbor Symposium Abstracts

Other Sources

Various Conservation Commissions (nonpoint source assessment)
Municipal and Industrial NPDES Permit Monitoring Requirements

The assessment uses this information to make a judgement about the degree to which the designated uses of a waterbody are supported. In some cases it is appropriate to make judgements based on other information than monitoring data. This information includes land use patterns, location of sources of pollution, predictive modelling and citizen complaints. Assessments made on these types of information or on monitoring data more than five years old are considered "evaluated waters". When the use support decision is based principally on current site-specific ambient data the waterbody is considered "monitored waters".

In monitored waters the judgement as to a degree of support is made by comparing water quality criteria for a particular use with measured values. The fishable use is determined primarily by dissolved oxygen, temperature, pH and toxics data. The toxics data includes sediment and fish flesh data in addition to water column data. The swimmable use is determined largely by the use of fecal coliform bacteria data. However, nutrient information, turbidity, transparency and aquatic plants information is also used. Table 3.1 summarizes the key criteria for these determinations.

The state classification system recognizes four additional uses in addition to the national goal uses: Public Water Supply in Class A waters, Open Shellfishing in Class SA waters, Restricted Shellfishing in Class SB waters and Secondary Contact Recreation in Class C and SC waters. Public Water Supplies are assessed by a separate set of regulations (310 CMR 22.00) by the Massachusetts Division of Water Supply. Open and Restricted Shellfishing uses are regulated separately by the Division of Marine Fisheries. The Division used information supplied by these agencies to determine degree of support for these uses. Secondary contact recreation is assessed using coliform bacteria and aesthetic criteria. The criterion for fecal coliform bacteria is 1000 organisms/100 ml (geometric mean). Aesthetic criteria are more subjective, but prohibit nuisance conditions.

The degree of support is divided into: (1) fully support; (2) partial support; (3)non-support and; (4) not attainable. In addition, "threatened waters" refers to those waters that fully support their designated uses but may not fully support these uses in the future because of anticipated sources or adverse pollution trends. The determination of use support status was made using the following guidelines. Fishable and swimmable goals were assessed independently (EPA, 1989).

The Fishable Goal: Water quality that provides for the protection and propagation of fish, shellfish, and wildlife [CWA 101(a)(2)].

It is the intent of the Act to define "protection" and "propagation" to mean ensuring that fish, shellfish, and wildlife populations are protected from man-made pollution that adversely affects their optimum health and reproductive viability. Therefore:

- Waters are fishable if they are of such chemical and bacteriological quality as to support fish, shellfish, and wildlife populations that are well balanced and at their optimum health and reproductive viability. Waters that naturally could support only a limited variety of fish/shellfish species are fishable if those species are healthy and viable. This includes waters meeting a lower fishery use for which EPA has approved the use.

- Waters are partially fishable if the fish/shellfish community suffers some adverse effect (e.g., lowered species diversity) due to pollution or habitat degradation yet is still generally viable.

- Waters are not fishable if they have fishing advisories or bans due to toxics in fish/shellfish tissue or pathogens in water at level of concern, or if the fish community is altered relative to the designated use due to pollution or habitat degradation, and the health and reproductive viability of the fish/shellfish has been adversely affected.

TABLE 3.1

WATER QUALITY CRITERIA

FOR THE FISHABLE/SWIMMABLE GOAL

PARAMETER	FRESH WATER	SALT WATER
Dissolved Oxygen	6.0 mg/l (CWF) 5.0 mg/l (WWF) 3.0 mg/l (A.L.)	6.0 mg/l
Temperature	68°F (CWF) 83°F (WWF) 85°F (A.L.) Δ 4°F	Δ 4°F
pH	6.5 - 9.0 standard units	6.5 - 8.5, 0.2
Fecal Coliform Bacteria	200 organisms/100 ml	200 organisms/100 ml
Toxic Pollutants	Gold Book	Gold Book

Notes:

CWF - cold water fishery
WWF - warm water fishery
A.L. - aquatic life
Δ 4°F - change from ambient
Gold Book - EPA publication Quality Criteria for Water 1986

- Waters are not attainable if they are naturally unable to support any fish/shellfish populations at any time, or suffer from irrevocable human-induced impacts where the State has obtained approval, based on a use attainability analysis, for standards that exclude aquatic life uses.

The Swimmable Goal: Water Quality that provides for recreation in and on the water.

It is the intent of the Act to ensure that waters are protected from man-made pollution that adversely affects primary and secondary contact recreation activities such as swimming, wading, and water skiing.

- Waters are swimmable if they are of such chemical and bacteriological quality as to safely and continuously support primary contact recreation. Waters that naturally support swimming only during a limited period of use should be considered swimmable if, during that time, water quality is good enough to permit primary contact recreation.

- Waters are partially swimmable if they are occasionally subject to short-term restrictions on swimming due to pollution, yet support swimming throughout most of their annual period of use.

- Waters are not swimmable if they are of such chemical and bacteriological quality as to be unsafe unsuitable for primary contact recreation. Waters with frequent temporary or long-term swimming restrictions should be considered not swimmable.

- Waters are not attainable if they could not naturally support swimming or suffer from irrevocable impacts and where a State has obtained approval, based on a use attainable analysis, for standards that exclude swimming goals.

3.2 Assessment

The assessment of surface waters was carried out using federal guidance (U.S. EPA, 1989). The guidance is sufficiently different from that of previous years guidance that direct comparison with previous 305(b) reports is not possible. However, data from the 1979 report was reanalyzed using the new guidance and is offered in this report to illustrate trends. The new guidance seeks to standardize 305(b) reports among states and is integrated with a computerized "Water Body System" for storing and generating assessment information. It is expected that all the states will be using this system by 1992, thus assuring uniformity for the future.

Tables 3.2 through 3.10 summarize the assessment of surface waters. In each table information is divided by waterbody type: a) rivers, b) lakes and c) marine waters. Information is reported in river miles, acres of lakes and square miles of marine waters. Table 3.2, "Designated Use Support," reports the degree of use support for each waterbody type based on the state classification system. Each Class has multiple uses - all uses must be met in order for a waterbody to be given full support. If one or more uses is not attained the waterbody is designated non support. Partial support means that there are periodic episodes of non support. Table 3.3 "Attainment of Clean

TABLE 3.2

DESIGNATED USE SUPPORT

DEGREE OF USE SUPPORT	Assessment Basis EVALUATED	MONITORED	TOTAL ASSESSED
a) Rivers (miles)			
Full Support	135.4	339.5	474.9
Threatened	3.2	90.9	94.1
Partial Support	66.6	399.5	466.1
Non Support	32.9	555.0	587.9
TOTAL	238.1	1385.9	1623.0
b) Lakes (acres)			
Full Support	2,019	2,262	4,281
Threatened	6,591	8,687	15,278
Partial Support	7,755	10,048	17,803
Non Support	714	25,943	26,657
TOTAL	17,079	46,940	64,019
c) Marine Waters (sq. miles)			
Full Support	0.56	17.07	17.63
Threatened	0	0.39	0.39
Partial Support	14.14	3.15	17.29
Non Support	9.31	91.71	101.02
TOTAL	24.01	112.22	136.23

TABLE 3.3

ATTAINMENT OF CWA GOALS

GOAL ATTAINMENT	FISHABLE GOAL	SWIMMABLE GOAL
a) Rivers (miles)		
Meeting	1060.8	681.6
Partially Meeting	208	619.8
Not Meeting	354.2	318.6
Not Attainable	-	3.0
b) Lakes (acres)		
Meeting	37,706	44,893
Partially Meeting	569	17,952
Not Meeting	25,663	1,080
Not Attainable	80	92
c) Marine Waters (sq. miles)		
Meeting	77.64	53.05
Partially Meeting	13.01	45.58
Not Meeting	45.58	37.60
Not Attainable	-	-

Water Act (CWA) Goals" reports on the national goal uses (fishable and swimmable). Tables 3.4 - 3.6 summarize the causes of non attainment for each waterbody type. The cause categories are standardized and defined in the federal guidance. "Major impacts" refer to sizes of waterbodies designated for non support due to a particular cause. Moderate/minor impact refers to sizes of waterbodies designated partial support due to a particular cause category. Tables 3.7 - 3.9 list the sources of non attainment by waterbody type. The source categories are divided into point and nonpoint sources. Major impacts list sizes of waterbodies that are designated as non support due to a particular source. Moderate/minor impacts list sizes of waterbodies designated as partial support due to a particular source. Table 3.10 summarizes the results of toxic monitoring in the state.

a) Rivers

DWPC has maintained a relatively fixed monitoring network for rivers over the past 20 years. This network covers 20% of the total river miles in the state. The monitoring program was designed to encompass every principal river in the state and all known or suspected polluted areas. It includes all the point sources of pollution in the state, all major urban areas, and areas otherwise suspected of non attainment (through other sources of data or citizen complaints). Therefore, it may be assumed that the remaining 80% of the river miles in the state meet their classifications. This assumption must be tempered by the fact that the system was originally designed to detect and analyze point sources. It is unlikely any major source of pollution (point or nonpoint) has gone undetected, but local nonpoint contributions may have escaped. A nonpoint source monitoring program designed to sample previously unmonitored areas of the state will be implemented and tested by DWPC during the summer of 1990.

The assessed rivers in the state include only the 20% routinely monitored. The majority of these rivers were severely polluted in the past, but have been the focus of the CWA clean-up programs since 1972. In order to show trends data from the 1979 305(b) report was reanalyzed using the 1990 federal guidance. This was the earliest report that had the necessary information for such an analysis. The 1979 report covered virtually the same rivers and monitoring stations (1,523 river miles in 1979 verses 1,623 in 1989). Tables 3.11 - 3.13 provide the comparison of the two assessments in percent.

The 1989 assessment is detailed by segment in Appendix I (Rivers and Marine Waters) and Appendix II (Lakes) of this report.

The 1989 assessment shows that 35.1% of the 1,623 miles assessed fully support their designated uses, 28.7% partially support their designated uses and 36.2% do not support one or more of their designated uses. These percentages are virtually identical with the 1979 assessment except for a small (5.8%) rise in waters that fully support their designated uses.

The fishable goal is met in over 65% of the waters assessed compared with over 59% in 1979. Waters not meeting the fishable goal have increased from 12.9% in 1979 to 21.8 % in 1989. This increase is due to

six major fisheries advisories/bans imposed since 1979 that affect approximately 10% of the waters assessed.

The swimmable goal showed a modest but significant increase from 33.2% fully supporting in 1979 to 42.0% fully supporting in 1989. There was a corresponding decrease in waters not supporting the swimmable use from 28.1% in 1979 to 19.4% in 1989.

There are five major causes of non attainment in 1989:

Cause	River Miles Impacted
1. Pathogen indicators	54.2%
2. Dissolved Oxygen	24.3%
3. Nutrients	23.8%
4. Priority Organics	12.1%
5. Metals	10.4%

Comparing these results with those from 1979 significant improvement can be demonstrated due to the construction of municipal wastewater treatment facilities. Ammonia and suspended solids were significant problems in 1979 - affecting 18% and 17% of the rivers, respectively. Impacts from these pollutants have been virtually eliminated. Impacts due to low dissolved oxygen and high nutrients which affected 40% of the river miles in 1979, impact less than 25% in 1989. The bacterial contamination of rivers has decreased by 10% over the past ten years but still remains at high level.

Priority organics and metals each affect more than 10% of the rivers in the state. This was not noted in 1979. The increase is not attributed to an increase in pollutant loadings but rather to:

1) increased parametric coverage in toxic monitoring;
2) decreased analytical detection limits for toxics; and
3) recent development of criteria for toxic pollutants.

The increase is due, therefore, to better monitoring and analysis techniques.

The sources of non attainment reveal the reason why the substantial gains in pollution abatement activities has not resulted in a corresponding increase in designated use support. The major sources of non attainment are:

Source	River Miles Impacted
1. Urban Runoff	39.6%
2. Municipal (point sources)	22.6%
3. CSOs	14.7%
4. Storm Sewers	11.3%
5. Land Disposal	10.0%

It is instructive to note that all but one of these sources (municipal point sources) are largely episodic impacts influenced

by rainfall events. Urban (and suburban) runoff is the single most significant source of non attainment in the state's rivers. The percentage of rivers affected has remained constant over the last 10 years (approximately 40%). Although there have been significant decreases in industrial and municipal point sources, urban runoff prevents these segments of rivers from attaining their designated uses. These impacts are largely detected in the receiving waters by pathogen indicators which explains why this remains such a significant cause of non attainment.

Other significant sources of non attainment are CSOs and storm sewers. The impacts from these sources have remained fairly constant over the past ten years. An apparent rise in storm sewer impacts is attributed to increased awareness of these sources and the fact the impacts were previously masked by other point sources of pollution. Other than urban runoff land disposal is the single most important source of nonpoint pollution. This category contains pollution due to failing septic systems and landfill and dump sites.

The apparent rise in "other nonpoint sources" is attributed to an increased awareness and sophistication in identifying these sources along with a decreased masking effect from point sources. A significant portion of this category refers to pollution from in-place sediments that are responsible for the fishing advisories/bans in the state. The point sources of these problems have been controlled but the effects linger on as a nonpoint problem.

b) Lakes

Tables 3.2, 3.3, 3.5 and 3.8 assess over 64,000 acres of lakes in the Commonwealth - 42% of the total. The data is heavily skewed by the inclusion of Quabbin Reservoir which has an area of 25,000 acres - 16.5% of the total lake acres of the state. The lake monitoring program is designed to assess baseline conditions on lakes, adding new lakes each year to the data base. Longer term studies are conducted on relatively few lakes based on available funding and priorities. The incremental nature of the data base is not amenable to trend analysis and none is attempted.

Of the 30.6% of the lakes assessed that fully support their uses, the majority have been categorized as threatened due to cultural eutrophication. Of the 41.6% of the assessed lakes acres that do not support their uses, over 93.8% of these belong to one lake - Quabbin Reservoir. This waterbody does not meet its use classification because of elevated mercury levels in fish.

Over 70% of the lakes assessed meet the swimmable goal and, with the exception of Quabbin Reservoir, 96.6% of the acres assessed meet the fishable goal. Less than 2% of the lakes assessed (again excepting Quabbin Reservoir) did not support their designated uses.

The major causes of nonsupport were:

	Cause	Acres Impacted
1.	Aquatic Plants	30.0%
2.	Nutrients	11.4%
3.	Suspended Solids	1.1%
4.	Metals*	0.6%
5.	Unknown	0.5%
6.	Pathogen Indicators	0.4%

* Not including Quabbin Reservoir

The sources of these impacts are largely unknown:

	Source	Acres Impacted
1.	Unknown	62.0%
2.	Land Disposal	6.8%
3.	Urban Runoff	3.7%
4.	Municipal (point source)	1.6%
5.	Agriculture	1.0%

These results are biased by the State's monitoring procedures. The lake sampling program is designed to classify lakes according to trophic status; using nutrients and aquatic plants as primary determinants. Likewise, since the goal of the monitoring is to establish the classification, sources of contamination are usually not determined. The state is currently analyzing its monitoring program and will modify it to better meet these needs. Lake water quality is discussed in further detail in Chapter 4 of this report. Information on individual lakes is provided in Appendix II.

c) Marine Waters

The marine monitoring program has been problem oriented. Major sampling efforts in Boston Harbor and Buzzards Bay tend to dominate the results. The coastline on Cape Cod and the Islands as well as large areas of open ocean were not assessed. Although 76.9% of the area of harbors and estuaries was assessed, the majority of marine waters (reported as coastal miles) remains unassessed. As with the river monitoring, the marine monitoring concentrates on the known and suspected polluted areas.

The assessment shows that 74.2% of the square miles analyzed did not support their uses. However, nearly 40% of the waters met the swimmable goal and nearly 60% met the fishable goal. The major cause of non-attainment was pathogen indicators which adversely affected over 80% of the waters assessed. Other sources of non attainment include:

CAUSE	AREA IMPACTED
1. Pathogen Indicators	81.3%
2. Ammonia	28.1%
3. Suspended Solids	24.6%
4. Dissolved Oxygen	13.3%
5. Metals	11.9%
6. Nutrients	10.5%
7. Priority Organics	8.4%

Most of the non attainment due to ammonia occurred on Boston Harbor, however moderate impacts were noted in Buzzards Bay and the North Coastal area. Metals were assessed as moderate problems in Boston Harbor, Buzzards Bay and the North Coastal area. Priority organics were causes of non attainment in the same three areas; of particular note is the PCB contamination of New Bedford Harbor. Suspended solids problems occurred for the most part in Boston Harbor with some impacts noted in Buzzards Bay. The only major dissolved oxygen problems were found in Boston Harbor but minor problems were fairly universal throughout the area assessed. The majority of nutrient problems and the priority organics (PCB) contamination were found in Buzzards Bay.

The major sources of nonattainment were:

SOURCE	AREA IMPACTED
1. Municipal (point sources)	51.3%
2. CSOs	43.6%
3. Industrial (point sources)	26.2%
4. Storm Sewers	14.5%
5. Other	32.4%

Unlike river waters, municipal point sources continue to pollute marine waters. Industrial pollution was largely confined to Boston Harbor. CSOs and storm sewers are significant contributors pollution all major urbanized areas. The category "other" denotes nonattainment areas in Boston Harbor for which specific sources of pollution have not been pinpointed.

Chapter 5 of this report further analyzes marine water quality in Massachusetts.

3.3 Public Health/Aquatic Life Impacts

a) Waters Affected by Toxics

The following chart contains the percentages of the total waters assessed that were 1) monitored for toxics; and 2) had elevated levels of toxics:

WATERBODY TYPE	MONITORED FOR TOXICS	ELEVATED TOXICS
Rivers	73%	20%
Marine Waters	60%	44%
Lakes*	12%	1%

* Not including Quabbin Reservoir

The chart shows that monitoring coverage for rivers and marine waters was good, but coverage for lakes was poor (baseline lake surveys are aimed at eutrophication rather than toxicity). Tables 3.14 and 3.15 further breakdown the river and marine waters data by drainage area.

The state's water quality standards incorporate the Federal guidance on toxic pollutants by reference. This guidance lists 126 toxic pollutants for regulatory purposes, with recommended maximum ambient concentrations for many of these (EPA, 1986). For the most part these levels are not exceeded in Massachusetts surface waters. Rather, high levels were exhibited in fish tissue and sediments. These environmental compartments are more difficult to assess because of a lack of criteria and less uniform sampling techniques.

DWPC submits all fish tissue data to the Office of Research and Standards (ORS) and the Department of Public Health for review. U.S. Food and Drug Administration (FDA) "action levels" are available for only eight pesticides, mercury and PCB's. In addition there exists an FDA dioxin advisory criterion for consumption of fish from the Great Lakes. Based on available data, several advisories have been put into effect in Massachusetts. These are presented in Table 3.16. Where a waterbody has a fishing advisory or a ban, the entire waterbody was assessed as having elevated levels of toxics. This includes 60% of the river miles assessed with elevated toxics and 65% of the marine areas.

There are no numerical sediment criteria in Massachusetts regulations. Therefore sediments are considered to have elevated levels when:

a) There is a demonstrated adverse biological impact determined through macroinvertebrate analysis or fish tissue analysis;
b) toxicity testing of the water column demonstrated toxicity to standard test organisms; or
c) levels of contaminants in the sediments exceeded those levels for a Category Three dredge or fill material in accordance with the Massachusetts Dredging and Filling Regulations (314 CRM 9.00).

In each case, those waterbodies with fishing advisories and bans were also assessed as having elevated levels in the sediments. The remaining waters on the list of those with elevated toxics were all primarily due to sediment contamination with exception of the Merrimack River. Portions of the Merrimack River had elevated levels of metals in the water column. The assessment shows that toxic problems in Massachusetts are largely due to a history of prior pollution or to the discharge of low levels of toxics that are either undetected or below toxic levels in the water column. These toxics subsequently accumulate in sediments and/or biota to levels that are toxic. In addition to the waterbodies with fishing advisories, the following areas were noted in the assessment as areas with significant sediment contamination:

Waterbody	Contaminants
Blackstone River	Metals, Priority Organics
Mystic River	Metals
North Shore	Metals, Priority Organics
Charles River	Metals, Oil and Grease

In addition to the Merrimack River (metals), significant water column toxicity was assessed in Boston Harbor and the Mystic River due to ammonia. Other toxics problems in the state were local and isolated and included chlorine toxicity, metals, and unknown toxicity.

Two fish kills occurred during the reporting period. One, on Chicopee Brook in the Town of Monson, was traced back to an industrial point source. The other occurred on Arcade Pond in Whitinsville and is attributed to improper herbicide treatment.

Fish abnormalities have been recorded at several locations in the state. Fin rot and liver tumors in fish from Boston Harbor are most likely due to the presence of carcinogens. Tumors observed on fish from the Sudbury River, Westborough Reservoir and Flint Pond in Shrewsbury are not believed to be pollution-induced but rather genetically-induced.

b) Public Water Supply

Surface water, the primary source of drinking water for approximately two-thirds of the population or 3.9 million people, is also the source of water for all major urban areas. The Quabbin and Wachusett Reservoirs account for more than half of these supplies and provide water to 2.1 million people served by the Massachusetts Water Resources Authority. Springfield, Worcester, New Bedford, Brockton and Fall River are also major surface water supply systems.

Ground water is the source of drinking water for approximately one-third of the population or 1.9 million people. Of these, 1.5 million use public wells and 0.4 million use private rural wells.

There are 499 community water systems. Of these, 157 are large systems which serve 88% of the State's population, 89 serve between 3,300 and 10,000, 253 are small systems; and there are 250 nontransient noncommunity systems.

The Safe Drinking Water Act Amendments of 1986 (SDWA) established a nationwide testing program for 59 volatile organic compounds (VOCs) in drinking water supplies. All public water supplies are required to monitor EPA specified maximum contaminant levels for 8 of these compounds:

Benzene	1,1,-Dichloroethylene
Carbon Tetrachloride	1,1,1-Trichloroethane
para-Dichlorobenzene	Trichloroethylene (TCE)
1,2-Dichloroethane	Vinyl Chloride

All public water suppliers are required to monitor and test for these compounds. The Division of Water Supply (DWS) set up a phased-in approach based on system size (310 CMR 22.00). Systems serving over 10,000 began testing in January 1988. Systems serving between 10,000 and 3,300 began testing in January 1989. Smaller systems will begin testing in 1990 and 1991.

In 1988, ground water sources were tested at least twice and surface water sources were sampled quarterly for systems serving over 10,000. All analyses were performed by one of 23 commercial laboratories certified for the analysis of VOCs in drinking water. New detection methods enable the detection of compounds that are present in minute quantities (generally 0.5 μg/l or parts per billion) that may not have been detectable previously. All testing data is reviewed by DWS as well as by public health specialists in DEP's Office of Research & Standards (ORS). ORS determines the health effects of any detected compound(s) and advises DWS on situations where a health risk is present.

While 47% of the water supply sources tested detected VOCs at low levels, only 11 sources showed VOC concentrations that presented a potential health risk. All of these sources have been taken off-line and some will be installing treatment. Ground water sources detected VOCs at least twice as frequently as surface water sources. These results support the need for greater protection of the Commonwealth's watershed and wellhead areas (see Table 3.18).

As of October 1986, contamination had caused the closure of public water supplies in 48 communities, resulting in the temporary or permanent lost of 111 public wells or wellfields across the State. Common sources of ground water contamination resulting in the closures include: industrial discharges, accidental spills or leaks, road salting, landfill leachate, sewage treatment plants, pesticides, and urban development. Naturally occurring elements such as iron and manganese and physical properties, such as turbidity, contributed to closure of 8 wells.

There were 2 surface water supplies closed temporarily in 1987; one from a leaking underground fuel tank and one from a release of heating oil.

By March 1989, 16 new communities experienced a loss of supply and 6 communities had repeat incidents. This translates to a loss of approximately 136 sources of supply over the last 19 years with the majority occurring in the last ten years.

In summary, 64 communities or 22% of municipalities with public drinking water supplies have had contamination incidents.

It is important to note that volatile organic chemicals are the major contaminant responsible for well closures. Table 3.17 is a breakdown of contaminant sources and closures; Table 3.18 is a listing of closures and contaminant sources from 1986 to 1989.

There were no incidents of water borne disease during 1988.

c) Shellfish Growing Waters

The shellfish growing areas in Massachusetts divide into two distinct zones. The area north of Cape Cod contains most of the large flats and commercial harvesting potential due to ecological and hydrologic reasons. South of Cape Cod the shellfishing industry is of much less natural importance[1].

During the decade from 1970 to 1980 shellfish beds along the shores of major urban areas were closed due to risk of bacterial contamination. The total area of closure was relatively stable. However, during the period of 1980 to 1989 thousands of additional acres have been closed to shellfishing due to bacterial contamination. Furthermore, these areas included many suburban and rural areas that were previously thought to be pristine. For example, during the period from 1980 to 1989, closures on the South Shore rose from 19,891 acres (31 square miles) to 41,976 acres (over 65 square miles). This increase includes a tenfold increase on Cape Cod and an over fourfold increase on the Islands:

	CLOSED ACRES	
	1980	1989
Cape Cod	712 acres	7,516
Islands	617	2,620

In contrast, the area north of Cape Cod has not experienced as rapid a rise in the rate of closures but the current conditions contain extensive closures. In this zone there are "Restricted Areas" where specially licensed diggers harvest moderately contaminated (with coliform bacteria) soft-shell clams for purification at the state-operated purification plant in Newburyport. All waters adjacent to Boston, Quincy, Hull, Braintree, Weymouth, Hingham and Winthrop are closed or restricted. North of the Boston metropolitan area approximately 40% of the productive flats are open. Since 1980 there have been some minor improvements with some prohibited areas reclassified as restricted[2].

Table 3.19 provides a breakdown of the acres of shellfish closures in the State. In addition to these areas closed to bacterial contamination, it is estimated that another 36% of the state's waters are closed due to management closures. Management closures occur in areas that are unsampled due to lack of available resources.

The data on shellfish closures provides valuable information on the areas of marine waters that were not assessed. The indications are that coastal water quality is deteriorating due to nonpoint sources of pollution. This condition is most probably due to rapid development of the coast, particularly in the area of Cape Cod.

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[1] Massachusetts Division of Fisheries and Game, 1930.
[2] Hickey, 1989.

3.4 CWA Section 304(l) Waters

Section 304(l) of the Federal Clean Water Act sets forth a nation-wide program for controlling toxic pollutants and toxicity in surface waters. The regulations require the state to develop several lists of impacted waters. The primary list contains all waters that, after the application of technology-based effluent limits, cannot reasonably be anticipated to attain standards. The causes may be conventional or toxic pollutants and the sources point or nonpoint. From this list, a priority list will be formed from the toxic problems due to point sources.

Table 3.20 contains the most recently updated 304(l) list for Massachusetts. It contains all the waterbodies not expected to meet standards after the imposition of technology-based control measures. Causes and sources are also listed.

TABLE 3.4

CAUSES OF NON ATTAINMENT

RIVERS (Miles)

	CAUSE CATEGORY	MAJOR IMPACT	MODERATE/MINOR IMPACT
1.	Unknown	-	3.0
2.	Unknown Toxicity	11.4	4.0
3.	Pesticides	-	19.5
4.	Priority Organics	190.3	7.0
5.	Non Priority Organics	-	-
6.	Metals	92.1	76.7
7.	Ammonia	21.3	10.7
8.	Chloride	10.4	0.5
9.	Other Inorganics	-	-
10.	Nutrients	62.3	323.8
11.	pH	-	4.7
12.	Siltation	-	-
13.	Dissolved Oxygen	117.7	276.4
14.	Salinity/TDS/Chlorides	2.5	15.2
15.	Temperature	-	-
16.	Flow Alteration	-	-
17.	Habitat Alteration	-	-
18.	Pathogen Indicators	414.7	464.6
19.	Radiation	-	-
20.	Oil & Grease	-	9.8
21.	Taste & Odor	-	-
22.	Suspended Solids	11.6	29.2
23.	Aquatic Plants	5	29.5
24.	Filling/Draining	-	-

TABLE 3.5

CAUSES OF NON ATTAINMENT

LAKES (Acres)

CAUSE CATEGORIES	MAJOR IMPACT	MODERATE/MINOR IMPACT
1. Unknown	320	-
2. Unknown Toxicity	-	-
3. Pesticides	-	-
4. Priority Organics	-	-
5. Non Priority Organics	102	-
6. Metals	25448	-
7. Ammonia	-	-
8. Chlorine	-	-
9. Other Inorganics	-	-
10. Nutrients	4208	3092
11. pH	-	-
12. Siltation	28	-
13. Dissolved Oxygen	22	40
14. Salinity/TSD/Chlorides	-	-
15. Thermal Modification	-	-
16. Flow Alteration	-	-
17. Habitat Alteration	-	-
18. Pathogen Indicators	18	268
19. Radiation	-	-
20. Oil and Grease	-	-
21. Taste and Odor	-	-
22. Suspended Solids	503	230
23. Aquatic Plants	10633	8287
24. Filling and Draining	-	-

TABLE 3.6

CAUSES OF NON ATTAINMENT

MARINE WATERS (Square Miles)

	CAUSE CATEGORY	MAJOR IMPACT	MODERATE/MINOR IMPACT
1.	Unknown	-	-
2.	Unknown Toxicity	-	-
3.	Pesticides	-	0.43
4.	Priority Organics	15.49	17.9
5.	Non Priority Organics	-	-
6.	Metals	14.1	24.20
7.	Ammonia	32.00	9.8
8.	Chlorine	-	-
9.	Other Inorganics	-	-
10.	Nutrients	0.83	13.5
11.	pH	-	-
12.	Siltation	-	-
13.	Dissolved Oxygen	2.3	15.76
14.	Salinity/TDS/Chlorides	-	-
15.	Temperature	-	-
16.	Flow Alteration	-	2.5
17.	Habitat Alteration	-	-
18.	Pathogen Indicators	94.72	16.1
19.	Radiation	-	-
20.	Oil and Grease	-	5.6
21.	Taste and Odor	-	-
22.	Suspended Solids	-	27.5
23.	Aquatic Plants	-	0.30
24.	Filling and Draining	-	-

TABLE 3.7

SOURCES OF NON ATTAINMENT

RIVERS (Miles)

SOURCE CATEGORY	MAJOR IMPACT	MODERATE/MINOR IMPACT
Point Sources		
Industrial	87.0	49.7
Municipal	137.9	228.9
Municipal Pretreatment	-	-
CSOs	186.8	51.2
Storm Sewers	91.7	90.2
Other	-	-
Nonpoint Sources		
Agriculture	11.2	59.5
Silviculture	-	-
Construction	-	29.0
Urban Runoff	195.5	447.5
Resource Extraction	-	-
Land Disposal	71.3	90.3
Hydro/Habitat Modification	-	-
Other NPS	135.1	164.1
Unknown	-	-

TABLE 3.8

SOURCES OF NON ATTAINMENT

LAKES (Acres)

SOURCE CATEGORIES	MAJOR IMPACT	MODERATE/MINOR IMPACT
Point Sources		
Industrial Point Source	45.00	0.00
Municipal Point Source	1031.00	0.00
Combined Sewer Overflow	0.00	0.00
Nonpoint Sources		
Agriculture	271.80	354.00
Silviculture	0.00	0.00
Construction	0.00	0.00
Runoff/Storm Sewers	1332.00	1021.80
Resource Extraction	0.00	0.00
Land Disposal	1337.00	3008.00
Hydro/Habitat Modification	0.00	0.00
Other	202.00	0.00
Unknown	11,460.00	28,205.30

TABLE 3.9

SOURCES OF NON ATTAINMENT

MARINE WATERS (Square Miles)

SOURCE CATEGORY	MAJOR IMPACT	MODERATE/MINOR IMPACT
Point Sources		
Industrial	7.72	27.92
Municipal	50.22	27.75
Municipal Pretreatment	-	-
CSOs	43.95	15.43
Storm Sewers	5.70	13.98
Other	30.30	13.90
Nonpoint Sources		
Agriculture	-	6.80
Silviculture	-	-
Construction	-	11.80
Urban Runoff	12.17	69.05
Resource Extraction	-	-
Land Disposal	2.31	20.09
Hydro/Habitat Modification	-	-
Other NPS	20.08	51.87
Unknown	-	-

TABLE 3.10

TOXIC MONITORING RESULTS

WATERBODY	MONITORED	ELEVATED LEVELS
Rivers (miles)	1188.0	325.4
Lakes (acres)	29,771	25,550*
Marine Waters (sq. mi.)	107.20	77.75

* Includes Quabbin Reservoir (25,000 acres)

TABLE 3.11

TREND ANALYSIS

1979 VERSUS 1989

Rivers (percent)

a. Designated Use Support

Degree of Support	1979	1989
Full Support	29.3	29.3
Threatened	-	5.8
Partial Support	32.9	28.7
Non Support	37.8	36.2

b. Attainment of CWA Goals

Goal Attainment	1979	1989
	Fishable Goal	
Meeting	59.4	65.4
Partially Meeting	27.7	12.8
Not Meeting	12.9	21.8
Not Attainable	-	-
	Swimmable Goal	
Meeting	33.2	42.0
Partially Meeting	38.6	38.2
Not Meeting	28.1	19.4
Not Attainable	-	0.2

TABLE 3.12

TREND ANALYSIS

CAUSES OF NON ATTAINMENT

1979 VERSUS 1989

Rivers (percent)

CAUSE CATEGORY	1979	1989
1. Unknown	-	-
2. Unknown Toxicity	-	0.2
3. Pesticides	-	1.2
4. Priority Organics	1.1	12.1
5. Non Priority Organics	-	-
6. Metals	2.2	10.4
7. Ammonia	18.0	2.0
8. Chlorine	<0.1	0.9
9. Other Organics	-	-
10. Nutrients	40.9	23.8
11. pH	3.6	0.3
12. Siltation	-	-
13. Dissolved Oxygen	39.7	24.3
14. Salinity/TDS/Chlorides	7.7	1.1
15. Temperature	-	-
16. Flow Alteration	1.4	1.7
17. Habitat Alteration	-	-
18. Pathogen Indicators	65.3	54.2
19. Radiation	-	-
20. Oil and Grease	0.3	0.6
21. Taste and Odor	-	-
22. Suspended Solids	17.0	2.5
23. Aquatic Plants	0.6	2.1
24. Filling/Draining	-	-

TABLE 3.13

TREND ANALYSIS

SOURCES OF NON ATTAINMENT

1979 VERSUS 1989

Rivers (percent)

SOURCE CATEGORY	1979	1989
Point Source		
Industrial	16.4	8.5
Municipal	35.6	22.6
Municipal Pretreatment	-	-
CSOs	18.9	14.7
Storm Sewers	2.1	11.3
Other	-	-
Nonpoint Sources		
Agricultural	4.9	4.4
Silviculture	-	-
Construction	0.5	1.8
Urban Runoff	40.2	39.6
Resource Extraction	-	-
Land Disposal	23.4	10.0
Hydro/Habitat Modification	-	-
Other NPS	2.0	18.4
Unknown	-	-

TABLE 3.14

WATERS AFFECTED BY TOXICS

. RIVERS

RIVER BASIN	MILES MONITORED	MILES ELEVATED LEVELS
Assabet	31	5.7
Blackstone	82.8	35.4
Buzzards Bay	15.1	1
Charles	87.2	14.4
Chicopee	45.6	0
Connecticut	67.5	67.5
Deerfield	77.7	3
Farmington	27.7	0
French	28.5	3.8
Hoosic	37.9	8.3
Housatonic	70.5	17.5
Ipswich	32.1	0
Merrimack	57.8	20.8
Millers	53.2	50.1
Mt. Hope Bay	0	0
Mystic	20.8	20.8
Nashua	56.8	0
Neponset	29.5	4.2
North Shore	31.9	17.1
Parker	22	0
Quinebaug	19.1	0
Shawsheen	25	0
South Shore	0	0
Stony Brook	3.7	0
Sudbury-Concord	63.9	25.3
Taunton	74.4	2.9
Ten Mile	31.6	27.6
Westfield	65.4	0
Weymouth-Weir	29.3	0
TOTAL	1188	325.4

TABLE 3.15

WATERS AFFECTED BY TOXICS

MARINE WATERS

	SQUARE MILES	
DRAINAGE AREA	MONITORED	ELEVATED LEVELS
Boston Harbor	47.3	43.9
Buzzards Bay	25.4	6.7
Merrimack	6.2	0
North Coastal	28.3	27.2
South Coastal	0	0
Taunton	0	0
TOTAL	107.2	77.8

TABLE 3.16
CONSUMPTION ADVISORIES

	Initiated
Boston Harbor (and Quincy Bay)	Jun 1988
Contaminant: multiple, not specified	
Full Advisory: lobster tomale	
Limited Advisory:* (sensitive groups) lobster, flounder, and bivalves	
* pregnant women, women who intend to become pregnant, children under the age of 12, and individuals with lowered immunity should avoid all consumption.	
Connecticut River	Apr 1988
Contaminant: PCBs	
Limited Advisory: (sensitive groups)* channel and white catfish	
Limited Advisory:** (general public) channel and white catfish	
* women of child bearing age	
** two meals per month	
Millers River (and Otter River)	Dec 1987
Contaminant: PCBs and mercury	
Full Advisory: (general public) brown trout and eel	
Limited Advisory: (sensitive groups)* all other species	
Limited Advisory:** (general public) all other species	
* pregnant women and nursing mothers	
** no more than two meals per month	
Quabbin and Wachusett Reservoirs	Aug 1987
Contaminant: mercury	
Full Advisory: smallmouth and largemouth bass, lake trout > 24"	
Limited Advisory: (sensitive groups)* all species except salmon and lake trout < 24"	
Limited Advisory:** (general public) all other species except salmon and lake trout < 24"	
* women of child bearing age and children under 12	
** one meal (5 ounces) per week	
NOTE: The general public and sensitive groups may eat unlimited amounts of of lake trout under 24 inches and all salmon.	

	Initiated
Sudbury River	Mar 1986
Contaminant: mercury	
Full Advisory: all species	
Ten Mile River (and Sevenmile River)	Jun 1986
Contaminant: lead	
Full Advisory:* all species	

* advisory being reassessed

Housatonic River	Apr 1989
Contaminant: PCBs	
Full Advisory: brown trout	
Limited Advisory: (sensitive groups)* all species	
Limited Advisory: (general public)** all species	

* pregnant women and nursing mothers
** two meals per month

Copicut River and Cornell Pond	Aug 1986
Contaminant: PCBs	
Full Advisory: American eel	
New Bedford Harbor	1979
Contaminant: PCBs	
Closure: Area 1 - all species (including shellfish) Area 2 - eel, flounder, scup, tautog (and lobster) Area 3 - (closed to lobstering only)	
Hoosic River	Apr 1989
Contaminant: PCBs	
Full Advisory: brown trout	
Limited Advisory: (sensitive group)* all other species	
Limited Advisory: (general public)** all other species	

* pregnant women and nursing mothers
** two meals per month
Note: pertains to the Hoosic River and its tributaries

CONSUMPTION ADVISORIES (CONTINUED)

		Initiated
Lake Winthrop (Holliston)		Mar 1986
Contaminant:	dioxin	
Full Advisory:	all fish	
Hocomoco Pond (Westborough)		
Contaminant:	PAHs	
Closure:	no fishing	
Statewide		Sept 1988
Contaminant:	not specified	
Full Advisory:*	lobster tomale	

* women of child bearing age

LEGEND

Closure:	Area legally closed to fishing
Full Advisory:	Advisory to eat no fish (or none of selected species)
Limited Advisory: (sensitive groups)	Advisory to avoid all consumption
Limited Advisory: (general public)	Advisory to limit comsumption

TABLE 3.17

NUMBER OF PUBLIC SUPPLIES CLOSED AND CONTAMINANT SOURCE[1]

ACTIVITY/SOURCE OF CONTAMINANT	1986-89	PRE 1986	TOTAL[2]
Volatile Organics	10	39	49
Industrial Storage/Discharge			
Illegal Disposal/Spills			
Petroleum Products	5	11	16
Non Point Sources			9
Sodium/Salt		8	
Runoff		1	
Landfills	1	7	8
Bacteria/Sewage		7	7
Pesticides	2	4	6
Detergents/Sewage Treatment Plant		1	1
Natural[3]			
Iron, Manganese	8	12	20
Physical Properties		12	12
Unknown	0	8	8
TOTAL	26	110	136

1 Counted as the primary source or suspected source of contaminant from DEP records.

2 If a community had 3 different wells or wellfields, this is counted as 3 supplies. This summation does not include an inventory of all wells in each specific wellhead.

3 No systematic program exists to survey the Commonwealth for the existence of naturally occurring contaminants - radon, arsenic, sulphides, uranium, etc., which <u>are</u> known to exist in the Commonwealth.

TABLE 3.18

PUBLIC WATER SUPPLIES CLOSED DUE TO CONTAMINATION - 8/1986-8/1989

MUNICIPALITY	SOURCE CLOSED	CONTAMINANT
Western Region		
Easthampton	Hendricks St., Wellfield	Volatile Organics
Holyoke	Pequot Wells	Volatile Organics
Westfield	Wells #3 & 4	EDB/Pesticide
Central Region		
Athol	South St. Well	Benzens, xylene, toluene
	Lake Ellis	Spill-heating oil
Dudley	Main Well	Benzene
Northborough	Lyman St. Well	TCE
Shrewsbury	Home Farm Well	TCE
Northeast Region		
Burlington	Well #7	TCE, other VOC's
Chelmsford	Revernick Well #1	TCE, PCE other
Cohasset	Lily Pond Reservoir	Leaking under. tank
Framingham	Birch St., Wells #1,2,3	Iron &/or manganese
Georgetown	Metcalf Well #1	Iron &/or manganese
Natick	Pine Oak Well #1	Iron &/or manganese
Peabody	Johnson St. Well	TCE, TCA, PCE, other
Reading	Well 82-20	TCE, PCE, TCA, other
Sudbury	Station #5	TCE
Tewksbury	Easement Road Well #2	Iron &/or manganese
Weymouth	Winter St. Well #1	Iron &/or manganese
Wilmington	Aldrich Road	Iron &/or manganese
Southeast Region		
Mashpee	Summerwood Community	Landfill
N. Raynham	First St. Well	VOC's
Oak Bluffs	Barnes Rd. Municipal Well	Leaking under. tank

KEY:

VOC - Volatile Organics
TCE - Trichloroethylene
TCA - Trichloroethane
PCE - Perchloroethylene, Tetrachloroethylene

TABLE 3.19

ACRES OF SHELLFISH CLOSURES

BASIN	ACRES CLOSED	ACRES RESTRICTED	SINCE 1987
North Shore	810	5,143	-
Boston Harbor	1,411.50	1,368.76	-
South Shore	7,278.7	-	1,708.7
Cape Cod	7,516.2	-	1,168.2
Islands	2,620.8	-	1,828.8
Buzzards Bay	16,505.4	-	-
Taunton River - Mount Hope Bay	8,055.4	-	-
TOTALS	44,198	6,511.76	4,705.7

TABLE 3.20

304(l) LIST

WATERS, AFTER APPLICATION OF TECHNOLOGY BASED EFFLUENT LIMITS, CANNOT REASONABLY BE ANTICIPATED TO ATTAIN STANDARDS DUE TO CONVENTIONAL AND 307(a) TOXICS POLLUTANTS FROM POINT OR NONPOINT SOURCES

WATERBODY	POLLUTANT(S)/PROBLEM(S)	REASON(S)/SOURCES(S)
	I. Major River	
Assabet River	Metals Dissolved Oxygen Bacteria	NPS Municipal
Blackstone River	Toxicity Metals Dissolved Oxygen	Sediment CSO Algae/Sediment
Charles River Basin	Toxicity Bacteria Dissolved Oxygen	CSOs Sediment
Connecticut River	Bacteria PCB Fish Advisory	CSOs Sediment
Deerfield River/Green River	Dissolved Oxygen	Municipal
French River	Toxicity Metals Dissolved Oxygen	Municipal Sediment
Hoosic River	Bacteria PCB Fish Advisory	NPS Sediment
Housatonic River	PCB's Toxicity Fish Advisory	Industrial Discharge Sediment
Merrimack River	Bacteria	CSOs
Mystic River	Bacteria	CSOs
Nashua River	Bacteria	CSOs
Neponset River	PCB's	Industrial Stormwater
Otter/Millers Rivers	PCB's Fish Advisory	WWTP (Industrial Product Residual) Sediment

TABLE 3.20 (CONTINUED)

WATERBODY	POLLUTANT(S)/PROBLEM(S)	REASON(S)/SOURCES(S)
Salisbury Plain River	Metals Toxicity	Municipal
Sudbury River	Mercury Fish Advisory	Sediment
Acushnet River	Metals Toxicity	Industrial Discharge
Ten Mile River	Metals Toxicity Fish Advisory	Sediment
	II. Small Streams	
Connecticut River/ Lampson Brook	Eutrophication	NPS Municipal
Mill Brook, Littleton	Toxicity Eutrophication	Industrial Discharge
Muddy Brook, Boylston (unnamed tributary to)	Organics	Stormwater from Oil Terminal
Muddy Cove Brook, Dighton	Toxicity	Industrial Discharge
Old Swamp River, Hingham (unnamed tributary to)	Toxicity	Industrial Discharge
Trout Brook, Avon	Toxicity	Industrial Discharge
	III. Marine Waters	
Boston Harbor	Organics Metals Fish Tumors	Municipal CSOs Sediment
Cape Cod	Bacteria	NPS
Lynn Harbor	Toxicity Bacteria	Municipal CSOs
Mount Hope Bay	Toxicity Bacteria	High Metals CSOs
Nahant Bay (Atlantic Ocean)	Toxicity	Municipal

TABLE 3.20 (CONTINUED)

WATERBODY	POLLUTANT(S)/PROBLEM(S)	REASON(S)/SOURCES(S)
New Bedford Harbor	Toxicity PCB Fish/Shellfish Ban Bacteria	Municipal CSOs Residuals
Salem-Beverly Harbor	Metals Toxicity Bacteria	Municipal Sediment
IV. Lakes		
Quabbin & Wachusett Reservoirs	Mercury Fishing Advisory	Sediment

4.0 LAKE WATER QUALITY ASSESSMENT

4.1 Trophic Status Of Lakes

Table A of Appendix II summarizes the trophic status of the lakes and ponds that were assessed for this report. In making this year's assessment some of the data were determined to be either too old or overlapping assessments of river segments. Thus, although 545 lakes and ponds have been surveyed since Massachusetts lake monitoring program began in 1974, only 414 lakes and ponds were assessed this year.

TABLE 4.1

TROPHIC ASSESSMENT SUMMARY

Assessed Trophic Status	Acres	# of Lakes
Dystrophic	37	1
Hypereutrophic	3,477	59
Eutrophic	17,758	202
Mesotrophic	15,751	124
Oligotrophic	26,995*	28
TOTALS	64,018*	414

Unknown Acres = 151,173 - 64,018* = 87,155
Lakes/Ponds Not Assessed = 2871 - 414 = 2457

* Includes the Quabbin Reservoir (25,000 acres).

The Commonwealth's current Lake and Pond Classification System classifies lakes by trophic status according to the methodology found in Appendix II. Realizing that the current system is inconsistent, particularly in the cases of shallow, macrophyte-dominated lakes, the Department of Environmental Protection is endeavoring to revise its assessment/classification process utilizing a Lake Water Quality Assessment Grant from the U.S. EPA. It is anticipated that, once developed, the new assessment/classification system will give a more realistic picture of the Commonwealth's lake quality and trends in eutrophication.

In the interim, trophic status assessments for this report were based primarily on best professional evaluation of the data available rather than the existing classification system. Thus, the apparent degradation of Massachusetts lakes (based on numbers in each trophic category) since the last Lake Water Quality Assessment (1988) may be more a reflection of the change in assessment procedure than a measure of changes in lake quality. However, this year's assessment is likely to give a more accurate representation of lake conditions in the Commonwealth.

It should also be noted that the Quabbin Reservoir was a significant addition to this year's assessment. Including the large surface area of this water supply reservoir results in an assessment of acreage that is significantly skewed toward oligotrophic when, in fact, most of the Commonwealth's lakes are not.

4.2 Restoration Efforts

a) Federal Clean Lakes Projects

The Commonwealth is mandated by the Federal Water Pollution Control Act to restore and maintain the chemical, physical and biological integrity of waters within the Commonwealth. Section 314 of the Clean Water Act establishes policies and procedures by which the Commonwealth may enter into cooperative agreements to restore publicly owned freshwater lakes and ponds and protect them against degradation.

The Commonwealth is currently administering ten (10) federally funded projects. Three of these projects are essentially complete pending the completion of final reports by the Commonwealth. One project has been terminated due to exorbitantly high projected costs for impact mitigation. Progress on the remaining projects has been slowed drastically because of the Commonwealth's fiscal crisis. These delays have led the U.S. EPA to request that five of these projects be terminated unless financial arrangements can be made by municipalities to ensure their timely completion.

b) State Clean Lakes Program

The Commonwealth, through its Department of Environmental Protection, Division of Water Pollution Control, administers the Massachusetts Clean Lakes Program. The purpose of the program is to restore, preserve or maintain the Commonwealth's publicly owned lakes and ponds for recreation and enjoyment.

The goals of the program are three fold:

a) To diagnose degraded lakes and ponds and implement, on a priority basis, long-term solutions for the purpose restoring their water quality. These long-term solutions must be shown to be feasible, cost-effective, and environmentally sound.

b) To diagnose lakes and ponds and implement, on a priority basis, methods for the long-term preservation of their water quality. This long-term preservation must be shown to be feasible and cost-effective.

c) To provide short-term remedial actions, on a priority basis, that relieve severe problems of nuisance aquatic macrophyton and/or phytoplankton and that maintain water quality conditions adequate for public recreation and enjoyment.

Each restoration, preservation, or maintenance project includes a watershed management plan to control and reduce nutrient and/or sediment loading to the lake, wherever possible, through best management practices.

Guidelines have been issued by the Commissioner of the Department of Protection under the authority of Chapter 628 of the Acts of 1981 (known as the Massachusetts Clean Lakes and Great Ponds Program), Chapter 286 of the Acts of 1982 (which provided funding for Chapter 628) and Chapter 722 of the Acts of 1969 (known as the Eutrophication and Aquatic Vegetation Control Program). These guidelines constitute a uniform and comprehensive program for the restoration, preservation and maintenance of the publicly owned lakes and ponds of the Commonwealth for public recreation and enjoyment. They establish policies and procedures by which applicants may apply for assistance to carry out approved methods and techniques for the above purposes.

A further description of the program may be found in the Clean Lakes Program Guidelines (revised April 1989). Currently no new funds are available for this program. However, seventy (70) projects are continuing to proceed using funds encumbered in previous fiscal years.

Table 4.1 enumerates the history of project funding under the Clean Lakes Program. Phase I projects are diagnostic/feasibility studies of lakes aimed at identifying existing and potential pollution problems and recommending cost-effective and feasible solutions. Phase II projects involve the implementation of the Phase I recommendations for long-term restoration and/or preservation of the lake and its watershed. Maintenance projects are short-term remedies for nuisance aquatic vegetation and algal problems.

TABLE 4.2

HISTORY OF MASSACHUSETTS CLEAN LAKES PROGRAM
(Number of Projects)

PROJECT TYPE	FISCAL YEAR 83	84	85	86	87	88
Phase I	23(23)	21(15)	12(6)	15(4)	13(1)	13(13)
Phase II	6(4)	9(7)	8(2)	20(6)	9(4)	9(8)
Maintenance	2(2)	5(5)	3(3)	3(2)	0	1(1)

NOTE: Numbers in parentheses indicate the projects that have been completed or terminated as of 12/31/89.

With the demise of the Commonwealth's Clean Lakes Program, efforts to retard eutrophication will fall on the federally supported Nonpoint Source Demonstration Program and on local initiative. Given the intensity of development in the Commonwealth and the many decades of neglecting the eutrophication problem these efforts are unlikely to effect much change in the negative trend.

4.3 Impaired/Threatened Lakes and CWA Goals

The water quality in the Commonwealth's lakes and ponds is summarized in Appendix II. Of the 2871 lakes and ponds in the state, 414 were assessed this year by the Division. Of these lakes 376 are considered impaired or threatened. Dense macrophyte growths and/or algal blooms, low transparency, high fecal coliform bacteria, and anoxia are the most common causes of impaired or threatened recreational uses. The impairment of the Quabbin Reservoir acts to skew the overall cause assessment. High levels of mercury in fish tissue analyses there have led to a fishing ban.

Specific sources of pollutants in Massachusetts are largely unassessed or unknown. Where assessments have been made, however, septic systems, stormwater runoff, and other nonpoint sources are most commonly noted. Although direct point discharges to lakes are almost nonexistent, data from several waterbodies along the Ten Mile River and French River systems indicate that upstream wastewater discharges have had significant impacts on them.

In addition, all available data were assessed in relation to the designated uses and CWA goals. The following criteria were used to make these assessments.

STATUS	CRITERIA
Fishable (Aquatic Life)	
Support	- Dissolved oxygen > 50% saturation.
Partial Support	- Dissolved oxygen <= 50% saturation for assessments based on one survey.
Non-support	- Dissolved oxygen <= 50% saturation for multiple surveys over the summer.
	- Fishing advisories/bans of any type.
Swimmable	
Support	- Fecal coliform < 200/100 ml.
	- Secchi disc transparency > 4 ft.
Partial Support	- Fecal coliform >= 200/100 ml for assessments based on one survey.
	- Secchi disc transparency <= 4 ft. for assessments based on the survey.
	- Cover of macrophytes (emergent, floating, or submerged growing to the surface) > 50% at their maximum extent of growth.

STATUS	CRITERIA
Swimmable (Continued)	
Non-support	- Fecal coliform >= 200/100 ml for multiple surveys over the summer. - Secchi disc transparency <= 4 ft. for multiple surveys over the summer. - Cover of macrophytes > 75% throughout the summer.

As with other lake assessments in this report the non-support status of the Quabbin Reservoir - because of a fishing ban-skews the overall assessment. Yet, even without the Quabbin Reservoir data the assessment (Table 3.2) clearly indicates that a majority of the lakes in Massachusetts are only partially supporting their designated uses or are threatened.

4.4 Acid Effects on Lakes

a) Acid Monitoring

The Commonwealth of Massachusetts Pond and Lake Information System (PALIS) database was used to generate lists (Tables 1-4, Appendix II) of state lakes and ponds with certain criteria that indicate the effects of acid deposition. Table 1 (Appendix II) indicates that only 12 lakes have been recorded as having pH values of 4.5 or less.

Tables 2-3 (Appendix II) are based on the buffering capacity of lakes. The Massachusetts Division of Fisheries, Wildlife and Environmental Law Enforcement (DWFWELE) has established the following three categories, based of total alkalinity values, to determine a lake's susceptibility to acid inputs.

CATEGORY	TOTAL AKALINITY ($CaCo_3$)
Vulnerable	6-10 mg/l
Endangered	3-5 mg/l
Critical	<= 2 mg/l

Using these categories as criteria lakes were listed from the PALIS database when at least one in-lake total alkalinity value fell within the range. When lakes appeared in more than one category they were listed according to the most recent data. Twenty-eight (28) lakes were identified in the Critical category (Table 2, Appendix II). The Endangered category contained 74 lakes (Table 3, Appendix II) and the Vulnerable category another 103 lakes (Table 4, Appendix II).

A database of broader scope is provided by the Acid Research Monitoring Project; a volunteer citizen monitoring program coordinated by the Water Resources Research Center at the University of Massachusetts. That program, which monitors lakes and streams on a quarterly basis, has monitored 2,099 lakes since 1985 (Walk, personal communication, 1990). Their records indicate

that 515 lakes fall into the Critical category, 398 are Endangered, and 432 are considered Vulnerable.

b) Acid Mitigation

The Massachusetts Generic Environmental Impact Report, Statewide Liming of Acidified Waters, 1985, stresses that "... the addition of ground limestone is the most biologically, socially and economically acceptable method for mitigating this problem (high acidity)." Lakes selected for liming by the Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement (MDFWELE) must meet each of the following nine criteria;

1) total alkalinity 2 ppm of less;
2) treat only great ponds or waters with a legal public access;
3) dystrophic lakes are excluded from treatment;
4) the lake's retention time must be a year or more;
5) metals concentrations must be below toxic levels;
6) the lake bottom cannot be dominated by mud or organic matter;
7) the mean depth must be eight feet or more and the maximum depth must be eighteen feet or more for a normal dose;
8) all waters must be screened by the Natural Heritage Program for rare and endangered plants; and
9) liming must be the most cost effective treatment.

One exception should be noted. Lakes that have "put and take" sport fisheries or important genetic stocks may be treated even if they do not meet all of the above criteria.

From 1987 through 1989, the MDFWELE, in conjunction with Living Lakes, Inc., a private corporation, limed five ponds. During the next two years (1990-91) they have 18 more treatments scheduled. Actual treatments will depend on the availability of state and/or federal funding.

c) Toxic Control

As stated in the liming selection criteria, the MDFWELE will not lime a lake if metal concentrations are above toxic levels. To date neither the MDFWELE nor the Department of Environmental Protection (DEP), Division of Water Pollution Control (DWPC) have developed mitigation methods or established plans to control toxics or metals mobilized by high acidity. Both agencies, however, have implemented sampling programs to monitor toxics in the environment. Currently these programs, stressing the public health concerns of environmental toxics, focus on locating areas of high concentrations and limiting the discharge of toxics to prevent toxic mobilization.

4.5 Toxic Effects on Lakes

Since the major thrust of the Massachusetts lake monitoring program has always focused on nutrient loading, the toxicity assessments have been made utilizing information from other programs; primarily the Division of Water Pollution Control's Biological Monitoring Program (including fish tissue analysis) and basinwide health advisories. As a result of these sources, thirty-three (33) lakes totaling 29,770.7 acres (including the 25,000 acre Quabbin Reservoir) have been assessed for toxicity of one type or another.

Ten (10) lakes were considered to have toxicity problems. Of these, six (6) were part of the Ten Mile River system where high levels of lead were found in fish tissue analyses. Isolated cases of mercury toxicity in fish tissue are responsible for three (3) of the other problem sites, including the Quabbin Reservoir. The remaining case is a result of elevated dioxin levels in sediments and fish tissue analyses at Lake Winthrop, Holliston. In all of the above cases fishing advisories or bans are in effect.

As a component of a Lake Water Quality Assessment grant from the U.S. EPA the Commonwealth's DWPC is expanding its lake monitoring program to include more frequent analyses of lake sediments for metals. Results from the 1989 surveys are currently being analyzed, but are not available for this report.

5.0 MARINE WATERS ASSESSMENT

The process of segmenting and assessing coastal waters requires an approach somewhat different than that used for rivers, therefore they are treated separately in this report.

Waters along the 2,400 km (1500 miles) of Massachusetts coastline are associated with several geomorphic features including open coast (composed of barrier beach, beach, or rocky shore), salt ponds, estuaries, bays, coastal embayments, and harbors (defined for this report as protected inlets).

Most of the data used for assessing coastal waters were collected in estuaries, harbors, bays and embayments. This trend developed for two reasons. First, these more enclosed areas are generally centers of human populations and are therefore the most impacted by contaminants from sewage, urban runoff and industrial discharges. Second, the most sensitive and important nearshore habitats, such as coastal wetlands, tidal flats, and shellfish beds are located in these same regions. The segmentation of the coast line that has been accomplished thus far has focused on estuaries, bays and other enclosed areas as opposed to the open coastline.

Because the linear miles of open coast and the square miles of all the enclosed areas have not been determined for the entire coast, it is often not possible to provide percentages of waters that were assessed or of waters that meet their use categories. Instead, what is often reported is the numbers of square miles of water that fit within a particular category. A good example of this is provided in Table 3.19 which shows shellfish bed closures and restrictions (major factors used in assessing the use attainment of coastal waters) for the drainage areas of the coast.

5.1 General Information

a) Hypoxia and Anoxia

Hypoxia, the condition in which dissolved oxygen (D.O.) concentrations are lowered to 3.0 ppm or less, is cause for concern in surface waters because it negatively impacts biological communities, and it can be a precursor to a more serious condition, anoxia, the total loss of D.O. in the sediments and water column.

The natural variability in the concentration of D.O. in surface waters, which results from oxygen production by plants during the day and oxygen consumption from community respiration at night, is confounded by estuarine processes. For instance, waters coming off of marshes in the upper reaches of an estuary can have D.O. concentrations as low as 3.0 ppm. This water then mixes with ocean water, which often has a D.O. of 9 ppm or higher, or the fresh, low D.O. water floats on top of the incoming, high D.O. saltwater resulting in a stratified condition. Either case (as well as other possibilities) results in continuing changes in the overall D.O. concentration. Because of this continued fluxuation it is difficult to accurately and completely describe D.O. in coastal waters. With a few exceptions, databases have not been developed for Massachusetts waters that will guarantee that all cases of hypoxia and anoxia have been detected in the areas in

which studies have been conducted. The data that are available, however, indicate that hypoxic conditions are infrequent, short-lived events in Massachusetts waters. Hypoxia most often occurs in the Boston Inner Harbor, but has been observed in Dorchester Bay, the Neponset River, Mt. Hope Bay, and Waquoit Bay and its tributaries.

Anoxia most often occurs in the sediments and along the very bottom several inches of the water column during worst case conditions. General water quality surveys are not designed to detect this condition, so the fact that anoxic conditions aren't often reported doesn't necessarily imply that they are not more common.

b) Point Source Nutrients

The major point source for nutrients into coastal waters is from municipal wastewater treatment facilities. The largest volumes of effluent are discharged from Boston (500 mgd), New Bedford (30 mgd), Fall River (23 mgd) and the Salem-Beverly region (41 mgd). Wastewater treatment plant effluents, of smaller volumes are discharged from Salisbury, Newburyport, Ipswich, Rockport, Gloucester, Manchester, Swampscott, Lynn, Cohasset, Scituate, Marshfield, Plymouth, Wareham, Marion, Fairhaven, Dartmouth, and Somerset.

c) Coastal CSOs

There are currently major efforts underway to mitigate the impacts of combined sewer overflows (CSOs) of coastal municipalities. The highest numbers of CSOs are located in Greater Boston, New Bedford, and Fall River, however significant problems are caused by smaller numbers of CSO's in Lynn and Gloucester.

5.2 National Programs

Currently, in the state of Massachusetts, there is one on-going national program, the Buzzards Bay Project. State agencies are, however, in the process of applying for the nomination of Massachusetts/Cape Cod Bays to the National Estuaries Program.

a) Buzzards Bay Project

In 1984, Buzzards Bay was recognized by Congress as a unique resource and was one of 4 estuaries in the Country selected for intensive study. The Buzzards Bay Project began in 1985 to characterize and assess water quality problems in Buzzards Bay and make management recommendations based on sound technical information. In 1988 Buzzards Bay was designated a estuary of national significance in the Environmental Protection Agency's National Estuary Program. Today the Buzzards Bay Project is one of 12 designated estuaries being studied in the U.S.

The Buzzards Bay Project is administered and funded by the Massachusetts Executive Office of Environmental Affairs (EOEA) through its Coastal Zone Management (CZM) Office, and the U.S. Environmental Protection Agency (EPA). The Project is directed by the Buzzards Bay Management Committee, a panel of

federal, state, regional, and community representatives. The Management Committee is advised by the Buzzards Bay Advisory Committee, a group of local town officials; the Technical Advisory Committee, a panel of scientists and technical specialists; the Management Plan Advisory Committee, a panel of local, state, and federal program managers and policy specialists; and the Coalition for Buzzards Bay, an independent citizens group concerned with the future of the Bay.[1]

b) Massachusetts Bay/Cape Cod Bay Project

In 1988 an Environmental Trust Fund was established primarily, to establish and fund the Massachusetts Bays Program. This program, intentionally modeled after the National Estuary Program, was designed to (1) increase the current knowledge and understanding of the Boston Harbor, Massachusetts Bay, and Cape Cod Bay System, (2) inform the public, stimulate interest, and facilitate communication about problems and issues facing the system, and (3) evaluate and improve management strategies for this system. The long-term goal of the Program is to provide a comprehensive evaluation of the sources and effects of contaminants and to produce an area-wide management plan for water quality protection.

The studies funded under the Massachusetts Bays Program are hoped to serve as a basis for future studies and the development of a comprehensive conservation and management plan under the National Estuary Program, should acceptance of the program for inclusion into that program occur.

5.3 Case Study: Buzzards Bay Project

Buzzards Bay is a semi-enclosed embayment located along the southeastern coast of Massachusetts. The eastern edge of the Bay is formed by Cape Cod and the southern edge by the Elizabeth Islands. The Bay is 28 miles long, and 9 miles wide, has a mean depth of approximately 36 feet, and covers approximately 235 square miles. The surface and ground water drainage basin for the Bay is 400 square miles and includes 17 municipalities. More than 250,000 people live in the Buzzards Bay Basin and well over 10,000 boats are moored in the Bay. The wastewater from approximately 135,000 people is discharged into the Bay by sewage treatment plants.

Buzzards Bay has long been the subject of water quality assessment by the Division of Water Pollution Control and other state and local agencies. Bay-wide studies have been conducted by the DWPC-Technical Services Branch in 1975 and again in 1984-85, with sporatic surveys of selected embayments and tributaries conducted in the interim. A water quality management plan was produced in 1976, and a revision is currently being prepared.

A major increase in monitoring effort came about in 1985 as a result of the establishment of the Buzzards Bay Project, a federally funded program which has led to inclusion in the National Estuary Program.

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[1] From the Buzzards Bay Project Fact Sheet "What is the Buzzards Bay Project", 9/89.

The primary goal of the Buzzards Bay Project is to assess pollution sources in Buzzards Bay and make management recommendations to protect coastal water quality and the health of living resources in the Bay. The Project has focused on 3 major areas: 1) pathogen contamination of shellfish beds and swimming areas, 2) nutrient enrichment and eutrophication of coastal waters, 3) contamination of shellfish and finfish by toxic chemicals.

The water quality of embayments around Buzzards Bay is declining because of increasing fecal coliform contamination, resulting in closures of shellfishing and swimming areas. Sources of the bacteria include stormwater discharges, animal wastes, failing septic systems, and boat wastes.

Increased development within the Bay's recharge area is causing excess nitrogen to reach Buzzards Bay. The excess loadings reduce the Bay's water quality, as evidenced by high turbidity, algae blooms, low dissolved oxygen, and a reduction in the area of eelgrass beds and shellfish habitat.

The major problems related to toxic contaminants pertain to the large amounts of polychlorinated biphenyls (PCBs) that were discharged into New Bedford Harbor between 1940 and 1970. Shellfish, lobsters, and flounder throughout the Bay are contaminated with PCBs, especially near New Bedford.

Currently, there are several activities of state, federal and local agencies (under the direction, and coordinated by the Federal/State Buzzards Bay Project). These include the updating of the Division of Water Pollution Control's Basin Management Plan and the preparation of a Comprehensive Conservation and Management Plan; workshops to address growth management, wetlands protection, shellfish protection, toxic and hazardous materials management, and sewage treatment options and management; increased sanitary surveys by the Division of Marine Fisheries; and the development of a monitoring plan to evaluate long term water quality trends.

6.0 WETLANDS INFORMATION

6.1 Extent and Utility of Resource

Wetlands include the swamps, bogs, meadows, marshes, fens, beaches, and intertidal areas found along the coastline and throughout the inland areas of the Commonwealth. The U.S. Fish and Wildlife Service estimates twelve percent (approximately 590,000 acres) of the land area in Massachusetts are wetlands (Tiner, 1989). A breakdown of Massachusetts wetland acreage by specific wetland type is presented in Table 6.1. Major wetland types by county are listed in Table 6.2. The percentage of wetland area in various Massachusetts counties range from 4% in Franklin County to 37% in Nantucket County. Wetlands occupy 20 to 25% of the land areas in the Barnstable, Bristol, Essex, and Plymouth counties; from 10 to 15% of the land area in the counties of Dukes, Middlesex, Norfolk, Suffolk, and Worcester; and about 5% of the land mass in Hampden, Hampshire, and Berkshire counties. In total, about twenty percent of Massachusetts wetlands consist of marine and estuarine environments. Most of the remaining 80% of wetland areas consist of deciduous forested wetlands. About 14,000 acres (2.3%) consist of farmed cranberry bogs.

Both inland and coastal wetlands are recognized to be one of our most valuable natural resources. Wetlands serve the important functions of filtering out pollutants and excess nutrients from our surface waters, removing contaminants from ground water, storing flood waters during rain and snow storms, and providing critical habitat to many species of wildlife.

6.2 Massachusetts Wetlands Protection Program

Due to the loss of thousands of valuable acres of wetlands in Massachusetts over past decades, the need to protect the remaining wetland resource areas in the Commonwealth is paramount. Massachusetts led the nation in wetlands protection by passing the first-ever statute in 1963 for coastal wetlands protection. A statute for inland wetlands protection was passed in 1965. In 1972 the two laws were consolidated to form the State's Wetlands Protection Act. The Act gives initial permit review authority to local conservation commissions. Volunteer boards are from 3 to 7 appointed members. All 351 cities and towns in the Commonwealth presently have conservation commissions. The Wetlands Protection Act requires these commissions to review and regulate activities which propose to remove, fill, dredge, or alter wetlands. Permits may be granted or denied based on impacts to the eight interests for which wetlands are protected: public and private water supply, ground water supply, prevention of pollution, storm damage prevention, prevention of flooding, protection of fisheries, protection of land containing shellfish, and wildlife habitat. Although wetlands are also considered to have aesthetic and recreational values, the current wetland regulations do not allow these attributes to be considered in the regulating activities in and around wetlands resource areas.

The Massachusetts regulations are among the most strict wetlands protection laws in the country. With passage of the coastal wetlands regulations, the alteration of valuable saltmarsh areas has been all but eliminated. Since passage of revised inland wetland regulations in 1983, the alteration of vegetated wetlands along inland rivers and streams has been greatly reduced.

TABLE 6.1 Massachusetts wetland acreage by type based on the U.S. Fish and Wildlife Service's National Wetlands Inventory. Wetlands are classified according to Cowardin and others (1979) (from Tiner, 1989).

WETLAND TYPE	ACREAGE
Marine Wetlands	
Beach/Bar	23,381
Intertidal Flat	14,303
Rocky Shore and Aquatic Bed	1,049
TOTAL	38,733
Estuarine Wetlands	
Emergent (includes 71 acres of Scrub-Shrub)	47,704
Intertidal Flat	29,227
Beach/Bar	2,214
Other Estuarine	122
TOTAL	79,267
Palustrine Wetlands	
Open Water and Aquatic Bed (Pond)	23,038
Emergent	24,240
Deciduous Forested	299,497
Evergreen Forested	27,415
Dead Forested (mostly beaver-modified)	2,964
Deciduous Scrub-Shrub	71,928
Evergreen Scrub-Shrub	2,725
Farmed (cranberry bog)	14,194
Other Palustrine	122
TOTAL	466,123
Lacustrine Wetlands	
Aquatic Bed	2,501
Emergent	1,291
Other	529
TOTAL	4,321
Riverine Wetlands	42
STATE TOTAL	588,486

TABLE 6.2 County wetland acreage summaries for Massachusetts based on NWI mapping (from Tiner, 1989).

COUNTY	MARINE WETLANDS (acres)	ESTUARINE WETLANDS (acres)	PALUSTRINE WETLANDS (acres)	LACUSTRINE WETLANDS (acres)	RIVERINE WETLANDS (acres)	TOTAL WETLANDS (acres)
Barnstable	20,416	23,113	15,066	50	-	58,645
Berkshire	-	-	29,259	631	2	29,892
Bristol	1,431	6,665	62,079	301	-	70,476
Dukes	1,389	2,012	2,949	51	-	6,401
Essex	3,960	22,762	41,930	106	-	68,758
Franklin	-	-	16,021	452	30	16,503
Hampden	-	-	20,913	91	-	21,004
Hampshire	-	-	17,290	289	10	17,589
Middlesex	-	-	58,004	349	-	58,353
Nantucket	6,625	1,093	3,068	-	-	10,786
Norfolk	54	3,470	29,554	101	-	33,179
Plymouth	3,702	17,615	75,749	413	-	97,479
Suffolk	1,156	2,537	579	-	-	4,272
Worcester	-	-	93,662	1,489	-	95,149
TOTALS	38,733	79,267	466,123	4,321	42	588,486

Except in very limited circumstances, these inland wetland regulations prohibit any alteration of wetlands greater than 5000 square feet. For most projects that come before conservation commissions, smaller alterations of less than 5000 square feet require replication on a one to one basis.

Another state program which protects wetland resources is the Water Quality Certification Program administered by the Division of Water Pollution Control. The Division of Wetlands and Waterways is currently working with the Division of Water Pollution Control on a long term strategy to make the 401 Water Quality Certification Program an effective wetland management tool. The Division of Wetlands and Waterways does not enforce Section 401 permit conditions. Enforcement of other wetland regulations is minimal because of staffing limitations and a significant backlog of permit requests.

6.3 Trends in Wetland Impacts

The number of proposals to work in or near wetlands is very high throughout the Commonwealth. The pressure to develop land in and near to wetland areas is increasing. Due to the increased value of land, areas that were once considered to be unsuited for development are now being reassessed. For the past few years, the central and western portion of the state has received the largest rate of increase in the number of wetland filings. Statewide, since 1978 there have been over 51,000 permit applications (Notices of Intent) submitted to conservation commissions for work proposed in/near wetland resource areas. Almost 9000 applications (Notices of Intent) to work in or near wetlands resource areas were received by the Department of Environmental Protection (DEP) during the 1989 fiscal year. An equal number of applications are expected to be received by DEP during the 1990 fiscal year. In the FY89, about one-third of these applications were from the Cape Cod and southeastern part of the State. About another third were for projects proposed in the metropolitan Boston and northeast section of Massachusetts. Central and western Massachusetts received the remaining third.

The U.S. Environmental Protection Agency estimates approximately 54% of the wetland area in the United States has been destroyed since the country was first settled. In Massachusetts, wetlands are frequently proposed to be altered for residential/commercial developments, highway expansions, roadway crossings, farming activities, mosquito control, construction or maintenance of public facilities, and recreational uses. The U.S. Fish and Wildlife Service determined that between 1977 and 1985/86 over 1300 acres of wetlands in Southeastern Massachusetts were destroyed (Tiner and Zinni, 1988). Approximately 820 acres of wetlands in this area were converted to either farmland or cranberry bogs. While total pond acreage exhibited a net increase of 150 acres, most (75%) of this gain was at the expense of converting existing wetlands. The majority (71%) of new pond acreage was ultimately utilized for cranberry farming. Additional information on the loss of wetland resources in other sections of Massachusetts is lacking. The Division of Wetlands and Waterways has applied to the EPA for a grant to develop a statewide wetland map which will be used to determine the current status of wetland resources in Massachusetts.

Massachusetts regulations require replication of altered wetlands on a one to one basis; however this requirement does not guarantee the replicated wetland will function as effectively as the natural area. A recent analysis of

wetland replacement projects throughout Massachusetts by the U.S. Army Corp of Engineers (1989) indicated that fifty-seven percent of replacement projects could be considered either "successful" or "conditionally successful" while thirty-six percent were considered unsuccessful. Increased attention should be given to conditions for constructing and monitoring replacement projects.

6.4 Goals of the Wetlands Protection Program

Even with the strict regulations that have been developed over the years, there is a need to do more to protect the Commonwealth's valuable wetlands resources. To meet this challenge, the DEP's Division of Wetlands and Waterways has added new technical staff, developed additional wetlands protection policies, and designed an education program to provide technical assistance to conservation commissions and the general public in the area of wetlands protection. Over the past few years the DEP has also amended the Wetlands Protection Act Regulations to provide further protection to wetland resource areas.

The Division has also recently reactivated the Wetlands Restriction Program. This proactive program is designed to identify important wetlands in each community and provide further protection to these areas by placing deed restrictions on properties to prohibit activities that would impair wetland functions. Approximately 42 coastal and 17 inland communities have some wetland restrictions in place encompassing over 46,000 acres of coastal wetlands and 8,000 acres of inland wetlands to date. During the next ten years the Restrictions Program will take aerial photographs (1:5,000 scale) of the entire state and map all wetlands. Restrictions criteria to identify wetlands important for water supplies will be developed in 1990. Other funding sources will be explored to delineate all wetlands in the state from a 1990 set of aerial photos developed under the National Aerial Photography Program in cooperation with the U.S.G.S. and the National Park Service. Additional funds would be required to transfer the wetland boundaries to a Geographic Information System (GIS) database. The Division recommends that the delineation and a share of the mapping project be considered for Section 404(c) funds.

7.0 GROUND WATER

7.1 Ground Water Discharge Permit Program

On October 15, 1983, the Department of Environmental Protection promulgated two regulations establishing the Massachusetts Ground Water Discharge Permit Program and the Massachusetts Ground Water Quality Standards. These two regulations, respectively, identified as Title 314 of the Code of Massachusetts Regulations, Chapters 5.00 and 6.00 (314 CMR 5.00 and 6.00) were designed to protect of all ground waters of the Commonwealth. Major features of the regulations include a state-wide ground water classification program and ground water discharge permit enforcement authority. Under the former, a mechanism has been created for other classification of the Commonwealth's ground waters with respect to protecting its most sensitive use. The three classes of ground waters are:

Class I: Fresh ground water found in the saturated zone of unconsolidated deposits or unconsolidated rock and bedrock are designated as a source of potable water supply.

Class II: Saline waters found in the saturated zone of the unconsolidated deposits or consolidated rock and bedrock are designated as source of potable mineral waters, for conversion to fresh potable waters, or as raw material for the manufacture of sodium chloride or its derivatives or similar products.

Class III: Fresh and Saline waters found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated for uses other than that as a source of potable water supply. At a minimum, the most sensitive use of these waters is as a source of non-potable water which may come in contact with, but is not ingested by humans.

Under 314 CMR 6.00, persons desiring a particular classification for a ground water were given until January 1, 1985 to submit a petition of request to DEP. DEP is currently reviewing all such requests and will assign classification based on the submittal data. Ground waters for which no specific classification petitions have been received will be designated as Class I, thereby affording protection to the most sensitive use - drinking water supply.

Reclassification may also be initiated by a petition which can be accepted at any time. Currently, 77 such petitions have been processed by the Department. Four (4) Class III designations have been granted.

All petitions must include certain minimum information including a description of the existing ground water quality, current and potential uses of the ground water, identification of potentially affected water supplies, and a statement of needs. Petitioners may also be required to submit a hydrogeologic study, the required detail of which will depend on the complexity of the area's geology, hydrology and the potential environmental impacts.

TABLE 7.1

DWPC GROUND WATER REGULATION SECTION

January 1, 1988 to January 1, 1990

Ground Water Discharge Permit Program

Applications received	97
Permits drafted	82
Permits issued	57
WWTF's inspected	46

Enforcement

DWPC Notices of Compliance	39
WPC Administrative orders issued	29
WPC Penalty assessments issued	27
Cases referred to the Attorney General	16

Title 5

Title 5 systems - plan review	884
Variances processed	1,610

Standards for granting a Class III designation include the following:

1) The ground water impacted by the classification is under single ownership by the discharger proposing the classification; or

2) The ground water affected by the classification is not a present or potential source of drinking water because:

   a) the depth of location of the ground water makes its use as drinking water economically or technologically infeasible; or

   b) the ground water is sufficiently contaminated to make its recovery for drinking water use economically or technologically infeasible; or

   c) the discharge is located over a federally-defined Class III well mining area subject to subsidence or catastrophic collapse; or

3) The ground water affected is a potential source of drinking water, but an alternate source is available and will be provided by the discharger proposing the classification to all existing and potential users of the aquifer affected by the discharge.

Furthermore, once all the above have been fully satisfied, the state will consider potential adverse effects on hydrologically connected surface and ground waters. The state must take into account future as well as present uses of adjacent water and ground water.

Currently, the protection of ground water from point sources of pollution is accomplished through the Department's Ground Water Discharge Permit Program administered by the Division of Water Pollution Control. All dischargers of pollutants into the ground waters require a wastewater discharge permit. This includes, but is not limited to: facilities discharging a liquid effluent below the land surface or into a percolation pit, pond or lagoon; facilities discharging a liquid effluent into leaching pits, galleries, chambers, trenches, fields and pipes; facilities discharging a liquid effluent into an injection well; any facility with an unlined pit, pond, lagoon or surface impoundment in which wastewaters or sludges are collected, stored, treated or disposed of; or conveyances that collect and convey stormwater runoff contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances or contact with a leaching facility. Since adoption of the 1983 regulations, the Department has received 502 permit applications and has taken final action on approximately 360.

Discharges to Class I and Class II ground waters must meet the more stringent of either the technology standards or the national primary and secondary drinking water standards. For parameters for which there are not drinking water standards, U.S. EPA Health Advisories are used as effluent concentration guidelines. Compounds which are considered toxic and for which there is neither a water quality standard nor a health advisory, are prohibited from discharge.

The discharge of sanitary wastewater in excess of 15,000 gallons-per-day requires a minimum of secondary wastewater treatment or its equivalent. All industrial process wastewater discharges are required to meet technology standards and the proposed treatment system must receive Department approval. These measures serve to ensure that the permitted discharge will be in compliance with Class I or Class II standards.

Discharge to Class III ground waters must also meet the more stringent of technology standards or water quality standards, but water quality standards for Class III ground waters are determined on a case-by-case basis and are generally less stringent than those for Class I or Class II aquifers. Water quality standards for Class III ground waters are determined based upon two most sensitive identifiable water uses. At a minimum, Class III ground waters must meet water quality criteria based upon human exposure limits.

In Massachusetts, each permit must contain monitoring requirements to assure compliance with permit limitations and conditions. DEP determines the number of wells, location, dimensions, method of construction, and frequency of reporting on a case-by-case basis. The State has established guidelines for making these determinations, and the guidelines vary according to the type of facility and the aquifer type under consideration. For Class I and Class II ground water, most of the monitoring will occur at the point where the effluent emerges from a treatment works, disposal system, outlet or point source prior to being discharged into the ground. For Class II ground water, the state will require monitoring between the point source and the compliance boundary.

An integral part of the ground water discharge permit program is the permit review process which encompasses all the divisions within the Department such as Water Supply, Water Pollution Control, and Hazardous Waste. The review process ensures that the environmental concerns particular to each division within the Department are considered and addressed.

Implementation of the Department's Administrative Penalty Program began on September 2, 1986. Authority granted under the Administrative Penalty Statute allows the Division to assess civil penalties up to $25,000 per day of violation per violation of permit limitations as well as unpermitted discharges. In excess of $500,000 has been assessed by the ground water section in a total of 31 cases. This program has proven to be a very effective tool in addressing non-compliance cases as well as providing an extra incentive to permittees to maintain compliance.

The majority of ground water discharge permits issued to date are for sanitary sewage discharged to the ground by small privately owned sewage treatment facilities. The total discharge flow rate is approximately 13.5 million gallons per day. Industrial discharges account for 28 ground water discharge permits with permitted flows in excess of 200,000 gallons per day.

7.2 Other Ground Water Quality Issues

In addition to municipal and privately owned wastewater treatment facilities, over 650,000 individual subsurface sewage disposal systems (septic systems) operate in the Commonwealth serving approximately 30 percent of the population, mostly in rural areas. Title 5 of the State Environmental Code (310 CMR

15.00) sets minimum design and siting criteria for individual subsurface disposal systems. Under the appropriate environmental conditions, these on-site systems can provide a safe and effective means of sanitary waste disposal, particularly in areas of low density development.

However, water quality impacts to both municipal and private drinking water supplies have been documented in densely populated areas which rely on septic systems. Wastewater treatment, even on the level of the individual home system, must be designed and regulated to protect ground water resources. Title 5 is currently under revision in order to better meet this goal.

Septic systems along with wastewater treatment facilities, industry, restaurants and commercial facilities produce residual waste. Conventional disposal methods such as incineration and landfilling have proven to be both ineffective and expensive. New technologies and methods, such as composting for beneficial uses, must be developed, evaluated and implemented. This may require both administrative and regulatory changes. In addition, waste constituents, particularly toxics, which make residuals so difficult to treat and dispose of properly must be better managed at the source. The recently enacted Toxics Use Reduction Law and the existing industrial pretreatment program are expected to provide relief over the long term. However, the problem exists now and will only worsen with time. The number of treatment facilities available for residual disposal number 51. The capacity of the 51 POTW's for residuals treatment is less than 100 million gallons per year, approximately one-third of the estimated 300 million gallons per year that should receive treatment. Clearly the lack of capacity poses a threat to ground water resources.

8.0 WATER POLLUTION CONTROL PROGRAMS

8.1 Background

The Department of Environmental Protection (DEP) is responsible for administering the State's regulatory programs for the protection of air, water and land resources. The organizational structure of DEP is based on three priority areas: Resource Protection, Waste Prevention and Waste Site Cleanup.

(1) Resource Protection: Oversees and coordinates the Water Pollution Control Program, the Water Supply Program, the Wetland and Waterways Program and other water related special projects.

(2) Waste Prevention: Oversees and coordinates the Hazardous Waste Program, the Solid Waste Management Program, and the Air Quality Control Program.

(3) Waste Site Cleanup: Oversees and coordinates cleanups under State and Federal Laws, and any similar cleanup activities. Regional offices have teams that respond to chemical and hazardous waste spills and accidents.

8.2 Point Source Programs

The Department's Bureau of Municipal Facilities (prior to July, 1988 it was known as the DWPC Construction Grants Program) has been the principal avenue through which substantial restoration of the Commonwealth's surface waters has been accomplished. Since its inception in 1966 (and its financial strengthening by the Federal Amendments to the Clean Waters Act of 1972), the Municipal Facilities Program has provided over $2.5 billion for the construction of new or upgraded wastewater treatment facilities and construction or replacement of sewer system components (pump stations, force main sewers, etc.). Although the financial expenditure has been substantial and has resulted in significant water quality improvements, the ultimate success of the program will require continued expenditure of significant funds over the next decade and beyond.

The Municipal Facilities Program develops an annual priority list for construction projects based on a ranking system which is presented at public hearings. Much of the current funding is being expended on Boston Harbor projects. The demand for funds far outstrips their availability, thus creating a backlog of eligible projects and extending the time for abatement programs to be completed. The source and availability of funding is in a state of flux. The majority of the $2.5 billion in funds expended over the past twenty years were federal EPA and state monies provided in the form of grants. The federal CWA of 1987 changed the federal funding from a grants program to a revolving loan program. The projects will be capitalized by combined state and federal funding sources, with substantial contributions from local entities. Federal grant monies will be phased out in 1990 as federal monies will be used as "seed" funds for the state revolving loan program. Between 1990-1994, EPA will provide funds to the states on the same formula basis as with the grants program. After 1994, EPA will cease providing funds to the state for wastewater treatment facilities. Future funding in Massachusetts will be made through low interest loans, combined with other legislative actions which hopefully will provide the necessary monies. The Hays Bill (H.B. 5500) recently approved by the Massachusetts Legislature will

TABLE 8.1

SURFACE WATER SURVEYS CONDUCTED BY THE TECHNICAL SERVICES BRANCH

1988 AND 1989

		WATER QUALITY		BIOMONITORING				
BASIN	WATER BODY	SYNOPTIC	INTENSIVE	MRB[2]	BIOACCUM.[3]	TOXICITY	PRIMARY[4] PRODUCTION	BACTERIAL INDICATORS
Assabet	Assabet River	x	-	-	-	x	-	-
Blackstone	Blackstone River	x	x	-	x	x	-	-
	Mill River	x	-	-	-	x	-	-
	West River	x	-	-	-	-	-	-
	Indian Lake	-	-	-	x	-	-	-
Boston Harbor	Boston Harbor	x	-	-	x	-	-	-
Buzzards Bay	Paskamansett River	x	-	-	x	-	-	-
	Copicut River	-	-	-	x	-	-	-
	Wankinco River	x	-	-	x	-	-	-
	Agawam River	-	x	-	x	-	x	x
Cape Cod	Waquoit Bay	-	x	-	-	-	-	x
Charles	Charles River	x	-	x	-	x	-	-
	Box Pond	x	-	-	x	x	-	-
	Lake Waban	-	-	-	x	-	-	-
	Cedar Swamp Pond	-	-	-	x	-	-	-
	Charles Basin	x	-	-	-	-	-	-
Chicopee	Quabbin Reservoir	-	x	-	-	-	-	-
	Ware River	x	-	x	x	-	-	-

TABLE 8.1 (CONTINUED)

BASIN	WATER BODY	WATER QUALITY		BIOMONITORING				
		SYNOPTIC	INTENSIVE	MRB[2]	BIOACCUM.[3]	TOXICITY	PRIMARY[4] PRODUCTION	BACTERIAL INDICATORS
Connecticut	Connecticut River	-	-	-	x	-	-	-
	Lampson Brook	-	-	-	-	x	-	-
Deerfield	Deerfield River	x	-	x	x	x	-	-
Farmington	Farmington River	x	-	-	-	-	-	-
Hoosic	Hoosic River	-	-	-	x	-	-	-
Ipswich	Ipswich Bay	-	x	-	x	-	-	x
Islands	Nantucket Harbor	x	-	-	-	-	x	-
Merrimack	Merrimack River	-	x	-	-	-	-	-
Millers	Otter River	-	-	-	x	-	-	-
	Whitney Pond	-	-	-	x	-	-	-
Mount Hope Bay	Watuppa Ponds	-	-	-	x	-	-	-
Mystic	Alewife Brook	x	-	-	x	x	-	-
	Malden River	x	-	-	-	-	-	-
Nashua	Nashua River	x	-	-	-	x	-	-
North Shore	Lynn Harbor	-	x	-	-	x	-	-
	Saugus River	-	x	-	-	-	-	-
	Pines River	-	x	-	-	-	-	-
	Essex Bay	-	x	-	x	-	-	-

TABLE 8.1 (CONTINUED)

BASIN	WATER BODY	WATER QUALITY		BIOMONITORING				
		SYNOPTIC	INTENSIVE	MRB[2]	BIOACCUM.[3]	TOXICITY	PRIMARY[4] PRODUCTION	BACTERIAL INDICATORS
Quinebaug	Quinebaug River	x	-	-	-	x	-	-
Shawsheen	Shawsheen River	x	-	-	-	-	-	-
South Shore	North River	x	-	-	-	x	-	x
Sudbury-Concord	Concord River	-	-	-	x	-	-	-
	Sudbury River	-	-	-	x	-	-	-
	Walden Pond	-	-	-	x	-	-	-
	Sandy Pond	-	-	-	x	-	-	-
Taunton	Threemile River	-	x	x	x	x	-	-
	Nemasket River	-	x	-	-	x	-	-
	Matfield River	-	x	x	x	x	x	x
Weymouth-Weir	Weymouth River	x	-	-	-	-	-	-

Notes: 1 Table does not include approximately 75 baseline lake surveys.
2 Macroinvertebrate Rapid Bioassessment (see text).
3 Fish Toxics Monitoring and/or blue mussel or seaweed analysis.
4 Includes chlorophyll and phytoplankton analyses and field assessment of excessive growths of aquatic vegetation.

provide funds for the revolving loan program for the correction of combined sewer overflows and the construction of wastewater treatment facilities and sewer system appurtenances. Local sources of funding to repay the loans and to finance the non-fundable projects will be increased through higher user fees and other financial arrangements. The shift in funding mechanisms will increase the individual contribution from citizens.

The Department will place great emphasis on replacing and upgrading treatment facilities across the Commonwealth to ensure that the environmental benefits gained over the past two decades are not lost. This attitude will allow for the maintenance of a viable infrastructure for sewer systems and treatment facilities across the state. This approach is directly in line with the Department's strong commitment to the preservation of environmental resources.

The Department issues (jointly with U.S. EPA) surface water discharge permits for all discharges to surface waters within Massachusetts. The permits contain effluent limitations for various parameters necessary to achieve compliance with the water quality standards and water uses of the receiving waters. The permit limits dictate the degree of treatment necessary for a wastewater discharge. In addition, the permit contains monitoring and reporting requirements which allow the state and U.S. EPA to track performance and compliance.

The Department's Regulatory Program undertakes enforcement actions against violators of the Department's regulations or those in non-compliance with discharge permit requirements. Actions that the Department can initiate include: notices of non-compliance; administrative orders; administrative penalties; show cause hearings; and case referrals to the State's Attorney Generals Office for action. These regulatory activities will continue to be a vital component of the Department's programs to ensure proper operation of municipal and industrial treatment facilities.

DEP also provides grants or loans to municipalities for constructing (and in some cases) for operating environmental protection facilities. Most are administered by the Bureau of Municipal Facilities. Others are managed by the Divisions of Water Pollution Control, Water Supply and Solids Waste.

8.3 Nonpoint Source Control Program

The Nonpoint Source Program was established by Section 319 of the Water Quality Act enacted by Congress in 1987. This section charges the states to develop and produce an Assessment Report and Management Plan and to implement their management program. The purpose of the program is to mitigate known nonpoint problems. One of the problems faced early in the program was the lack of data on smaller tributaries, lakes, pond and many coastal areas. Although further evaluation of waterbodies was not intended to be included under 319, it was felt that monies could be misdirected unless a complete picture of water quality in Massachusetts was available. In answer to these letters were sent to conservation commissions in each town requesting information on any known or potential water quality problems. Approximately thirty percent responded. In addition, water quality surveys and phone calls received have resulted in more information. Further work will include Rapid Biological Assessment as a quicker way to more accurately determine water quality impacts. The first round of projects is about to begin. These will

give a proving ground for many existing best management practices (BMPs) and abatement procedures as well as possibly finding new approaches and methodologies.

a) There are currently eight projects which are being or will be funded this year under the section 319 grant. A brief description of each is as follows:

- A study to define nitrogen loading to Waquoit Bay via ground water.
- A study to determine the effectiveness of retention/detention basins in protecting wetlands from stormwater runoff.
- A demonstration project using alternate methods of fertilization and pest control to reduce nutrient and pesticide loadings to surface waters from cranberry bogs.
- Rehabilitation of Sterling sand filter beds and an evaluation of the effectiveness of four different modes of operation for the removal of pollutants in runoff from the center of town.
- Demonstration and hands on training workshops in "Bioengineering" to stabilize streambanks on the Blackstone and North (Colrain) Rivers.
- Development of a methodology for the determination of maximum ground water elevation at times other than wet seasons. (May be included in Title 5 revision.)
- Development implementation and enforcement of a DEP underground storage tank regulatory program.
- Development and implementation of a nonpoint source enforcement program.

b) Soil Erosion and Sedimentation Bill was refiled for 1990.

c) As part the Nonpoint Source Program's assessment of unassessed waters Rapid Biological Assessment will be used. It was felt that the fauna of a stream would be the best indicator of water quality overtime. This is because they are not only affected by what is happening now but also by what has happened in the past as opposed to a physical/chemical sample which is just a snapshot in time. In order to determine effects from nonpoint sources without having to schedule sampling for runoff events DWPC is experimenting with a combination of Biological Assessment combined with traditional analysis and land use to determine its effectiveness.

8.4 Costs and Benefits of Clean Water Programs

The benefits of clean water programs, although myriad, are more difficult to quantify than the costs. The most obvious benefit of clean water is its use as a potable water supply. In Massachusetts the average water use is 160 gallons per capita per day. Two thirds of this (610 MGD) comes from surface water withdrawals and one-third is supplied by ground water from 1400 wells or wellfields. The Quabbin and Wachusett Reservoirs Service nearly half of the State's population (2.5 million people). The cost of building a treatment facility for Quabbin Reservoir has been estimated between 500 million and a billion dollars. Maintaining clean water is much more cost effective than attempting to restore polluted water.

Water is also used by industry for inclusion into nonfood products, processing and cooling. One and a half billion gallons per day of Massachusetts surface waters are withdrawn for these purposes. Business and industry have been attracted to the idea of the clean water. Many businesses support watershed associations because they believe it is economically important to improve and protect water quality. The opportunity to enjoy relatively unspoiled countryside within easy reach of more developed areas is important to Massachusetts residents. Waterbodies are often the primary attraction of state forests and parks. Some 20,000 acres of farmland in Massachusetts are irrigated. Twelve thousand of the acres are involved with the 90 million dollar per year cranberry businesses. Many of these farmers use water that is diverted from rivers and streams. A significant number of local utilities use water for cooling purposes, and the state also has 95 licensed hydropower dams generating over 308,000 kilowatts.

Massachusetts residents spend 492 million dollars per year on freshwater fishing, according to the U.S. Fish and Wildlife Service. Anglers spend another 579 million dollars per year on related gear, food and lodging, and an additional 248 million dollars per year is spent on boating. It is estimated that 30% of the state's 6.7 billion dollar tourist industry (41 billions indirect income) is based on people who come to Massachusetts for outdoor recreation. (MA Audubon, "Eden's End.") Over 450,000 people visited Quabbin Reservoir in 1988 (MDC).

Shellfishing and commercial fishing are major businesses for the state, bringing in 278.9 million in direct income according to the 1987 National Marine Fisheries Survey. Audubon estimates that the state is losing as much as 79 million dollars per year due to the loss of shellfish beds closed by contamination from human pollution.

Trout Unlimited, one of the most active groups of anglers in the country, has almost 1000 members in Massachusetts. Over 260,000 residents buy freshwater fishing licenses each year; another 17,000 people from out of state purchase licenses. There are watershed associations in most of the major river basins and a number of the smaller ones. Their membership numbers in the thousands. River events like the Annual Head of the Charles generally attract over 5,000 participants and 200,000 viewers each year.

Since 1972 nearly 3.0 billion federal/state/local dollars have been spent on clean water programs in Massachusetts. Major improvements have been achieved. Of the over 1500 river miles that were polluted in the early 1970's, one-third have been cleaned up to their water quality classifications (and two-thirds now meet the fishable goal).

Considerable effort in the last 10 years has been focused on upgrading treatment facilities. In a recent study (Webber, 1989) effluent and river water quality pollutant loadings were compared for ten wastewater treatment plants in Massachusetts that were upgraded from secondary to advanced within the past ten years. The biochemical oxygen demand (BOD), suspended solids (SS), ammonia (NH_3) and total phosphorus (TP) loadings in the water and wastewater before and after the plants upgradings were compared. It was found that when upgraded from secondary to advanced, the average BOD loadings were reduced an additional 87%, SS loadings were reduced an additional 89%, NH_3 loadings were reduced additional 84% and TP loadings were reduced an additional 71% above their secondary removal rates.

Construction costs of upgradings averaged 3.38/gallon removing an average of 6177 lbs/day of BOD, SS, NH_3 and TP pollutants per plant. These reductions have causedlarge pollutant reductions instream; improving the water quality considerably. Reduced pollutant loads have increased the instream dissolved oxygen, reduced the solids and corresponding sediment accumulation and SOD, and reduced the nutrients and corresponding algal growth.

Many of the improvements in water quality have been due to treatment plants which are now reaching the limits of their lifespans or capacities. More money will be necessary to maintain the gains of the past 20 years. The average cost for a new plant is $5/gallon. Based on an average plant size of 11.6 million gallons per day it takes an average of 12 years and 55 million dollars to upgrade or replace a treatment facility.

A massive effort has begun toward the cleanup of Boston Harbor. It is estimated that secondary treatment of the wastewater that now enters the harbor will cost 6-8 billion dollars. A billion dollars or more additional funds will be needed to address combined sewer overflows in the harbor. Achieving the maximum benefit from this huge expenditure will be a challenge to the facilities planning process.

8.5 Monitoring Program

The surface water monitoring program of the Division of Water Pollution Control is administered by the Technical Services Branch in Westborough and comprises water quality and biomonitoring of lakes, rivers, and coastal waters throughout the Commonwealth. A brief description of the monitoring programs is presented below and a list of surveys conducted during 1988 and 1989 is provided in Table 8.1.

a) River Monitoring

There are two types of surveys conducted on the rivers of the Commonwealth. These surveys include all major components (including tributaries and wastewater inputs) and are composed of physical, chemical and biological parameters (see Table 8.2 below). There are synoptic one-day, one-run surveys of grab samples only, and there are intensive surveys. Intensive surveys consist of round-the-clock sampling for two to three consecutive days for one to two weeks in the summer. The surveys are generally conducted during low-flow conditions and samples are usually composited.

River stations are located at dams, and below discharges, at tributaries, and at impoundments. These locations are chosen to assess the water quality and effects of outside sources and natural changes. Surveys are conducted periodically to update old data and sample rivers before and after a major upgrading of a treatment plant or the addition of a new discharge.

River surveys are usually supplemented by wastewater discharge sampling which serves to document pollutant loadings to the river at the time of the survey, and to assess compliance with NPDES discharge permit limits. Special studies are occasionally conducted on individual wastewater treatment facilities. These studies include intensive sampling throughout the process from the influent to the final effluent and help to assess treatment effectiveness.

Once sampling is completed and data are received from the laboratory, results are presented and discussed in technical memoranda or published reports.

TABLE 8.2

TYPICAL SURVEY ELEMENTS

TYPE	PARAMETER
Physical	Flow
	Temperature
	Suspended Solids
	pH
Chemical	Dissolved Oxygen
	BOD
	Nutrients
	Chlorides
	Trace Elements
Biological	Chlorophyll a
	Coliform Bacteria
	Phytoplankton
	Benthic Invertebrates
	Fish
Toxics	Metals
	Organics
	Microtox™

b) Lake Monitoring

The Division's Lakes Water Quality Monitoring Program was formally initiated in the summer of 1974 and has significantly expanded its scope over the past decade. Limnological sampling is conducted a) to determine baseline lake conditions, b) to monitor post-implementation projects and c) to respond to public concerns about lake problems.

A baseline survey is generally conducted in one day and consists of bathymetric mapping of the lake; physical, chemical and biological sampling of the open water areas, tributary stream(s), and outlet; and a quantitative and qualitative mapping of the aquatic macrophyton community in the lake. The primary purpose of this survey is to estimate lake trophic status and identify any point and nonpoint sources of pollution. The lake is sampled during the summer months when productivity is high.

Post-implementation or post-construction monitoring is conducted generally over a three-year period to evaluate the effectiveness of a lake restoration project. The monitoring program is individually tailored to the specific implementation project. The sampling schedule, stations and parameters, therefore, are selected accordingly.

Lake studies performed during the period 1988-1989 are not included in Table 8.1. However, this information is provided in the report entitled Massachusetts Lake Classification Program (MDWPC, 1989).

c) Coastal Monitoring

Because of the increasing concern with coastal pollution, a Marine Section of the Technical Services Branch was formed in early 1986. A major activity of this group has been the continued monitoring of the quality of coastal waters. Salem-Beverly Harbor and New Bedford Harbor, as well as relatively unpolluted areas such as much of Buzzards Bay, Cape Cod and the Islands. The polluted areas are monitored to assess improvement in water quality when water pollution control measures are instituted. Unpolluted areas, on the other hand, must be carefully monitored in order to gain the knowledge necessary for their continued preservation.

A second major activity of the Marine Section has been the special studies conducted in Buzzards Bay as part of the EPA Bays Program. The overall objective of this work is to combine monitoring with detailed investigations into the mechanisms and processes that control the fates and effects of pollutants entering coastal waters. These studies will be useful not only in expanding DWPC's understanding of marine pollution and the means to monitor it, but will also provide information for making more meaningful management decisions.

d) Biomonitoring

The Biomonitoring Program is an integral component of the state-wide surface water quality monitoring program which is authorized by the 1983 Massachusetts Clean Waters Act, Section 27, paragraph 8. The importance of biological monitoring is underscored in the "Declaration of Goals and Policy" Section 101 (a) of Public Law 92-500 (1972) which stresses the need to restore the biological integrity of the nation's waters and achieve a water quality which provides for the protection and propagation of aquatic life.

The Biomonitoring Program comprises four areas of emphasis: macroinvertebrate rapid bioassessment (MRB), fish tissue monitoring, toxicity assessment (including bioassay), and microbiology (including a phytoplankton/chlorophyll support laboratory). Biomonitoring personnel conduct biological sampling and analyses to supplement other water quality monitoring and management programs, and make recommendations with regard to the control of toxic effluents and thermal discharges through the NPDES permitting process. A Biomonitoring Program Standard Operating Procedures (SOP) manual documents all field and laboratory methods used by Biomonitoring personnel while carrying out the various program elements. This manual is updated periodically. The following

discussion provides more detailed information on each biomonitoring element. In addition, a list of biomonitoring surveys undertaken during the years 1988 and 1989 is presented as part of Table 8.1.

Macroinvertebrate Rapid Bioassessment (MRB)

This rapid assessment technique involves the use of semi-quantitative sampling methods designed to minimize laboratory time requirements for taxonomic identification and enumeration of aquatic macroinvertebrates. The MRB provides standardized procedures for assessing the impacts of organic and toxic pollutants on aquatic invertebrates; and it provides the basis for making relative comparisons pertaining to water quality conditions between sampling stations and/or to document long-term trends at fixed sites.

An upstream-downstream sampling regime is usually employed whereby known or suspected sources of pollution are bracketed by sampling stations. Impact assessment is carried out by making structural and functional comparisons between upstream reference communities and downstream impacted communities.

For the MRB, the members of a 100-organism subset of a larger sample are identified to genus or species level. The taxonomic data are then compiled to determine the status of various criteria used to rank water quality. These criteria include:

1) Species richness;
2) distribution "balance";
3) EPT value (number of taxa in Ephemeroptera, Plecoptera, Trichoptera);
4) percent contribution, pollution tolerances, and feeding habits of the five numerically dominant species; and
5) Hilsenhoff Biotic Index (HBI).

Based on the above criteria, an overall evaluation of each sampling site is made by characterizing the invertebrate community as follows:

1) Non-impacted
2) Slightly Impacted
3) Moderately Impacted
4) Severely Impacted

The MRB is conducted at up to 25 sampling sites per year in conjunction with comprehensive water quality surveys. Results are used to supplement traditional physicochemical analyses by demonstrating actual instream impacts of pollutants, as well as assessing ambient water quality and habitat conditions throughout a particular watershed.

Bioaccumulation Studies

Bioaccumulation surveys of the Technical Services Branch include the Toxics-in-Fish Monitoring Program aimed primarily at the assessment of human health risk associated with the consumption of contaminated fish, and special studies whereby organisms such as blue mussels or seaweed

are assayed for the presence of toxic contaminants as a measure of environmental impact.

The Toxics-in-Fish Monitoring Program is a cooperative effort involving the Division of Water Pollution Control, Division of Fisheries and Wildlife, DEP-Office of Research and Standards, DEP-Lawrence Experiment Station, and the Department of Public Health. In addition, the U.S. Fish and Wildlife Service provides technical assistance and some analytical services for special studies. Fish tissue monitoring is conducted to assess the levels of toxic contaminants in freshwater fish, identify waterbodies where those levels may impact human health, and identify waters where toxic chemicals may impact fish and other aquatic life. Fish surveys generally have been restricted to waterbodies where wastewater discharge data or previous water quality studies have indicated potential toxic problems. Furthermore, sampling has been conducted in areas where heavy industrial development or hazardous waste disposal are present. Because of limited resources, human health concerns have received highest priority in the surveys carried out thus far. Therefore, fish tissue analysis has been restricted to edible fish fillets.

Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, are followed for fish collection, processing and shipping. Fish are taken with electroshocking gear or gill nets. Lengths and weights are measured, and fish are visually examined for tumors, lesions, or other indications of disease. Scale samples or other hard parts (e.g., pectoral spines) are obtained from each sample to determine the approximate age of the fish.

Once at the laboratory, samples may be analyzed for specific toxicants (where a particular source is suspected) or for a broad spectrum of heavy metals, pesticides, or organic chemicals. Laboratory analytical methods include atomic absorption spectroscopy and gas chromatography/mass spectrometry.

Use of mussel and seaweed assays as a monitoring tool for evaluating the extent of toxic contamination in Massachusetts coastal waters is currently being explored on a limited basis as time and resources permit. Work to date has focussed on both heavy metals and organic contaminants (e.g., PCBs, PAHs) in blue mussels and heavy metals in seaweeds such as the brown alga, Fucus sp.

Toxicity Testing

The in-house toxicity testing capabilities of the Biomonitoring Program are presently limited to the use of one Microtox™ Analyzer. This analyzer uses a lyophilized (freeze-dried) marine bioluminescent bacterium, Photobacterium phosphoreum, which, upon reconstitution, emits a fairly constant level of light. Upon exposure to a toxicant, the level of bioluminescence is diminished in direct proportion to the toxicant concentration. Toxicity testing by other laboratory methods are conducted under a cooperative agreement with the U.S. EPA New England Regional Laboratory in Lexington, MA, and through an R&D Services contract with a private laboratory. These laboratories conduct

standard acute and chronic toxicity tests on freshwater and marine organisms according to EPA - approved methods.

Toxicity data are used to assess the impacts of point and nonpoint sources of toxic contamination in surface waters throughout Massachusetts and to formulate recommendations for abating toxic pollution through the NPDES permitting process, toxicity reduction evaluations (TRE's), and other water quality management strategies.

Objectives of the Microtox™ toxicity assessment program are:

1) To assess the effectiveness of municipal and industrial wastewater treatment facilities in eliminating aquatic toxicity;

2) to selectively screen water and sediment samples prior to conducting more expensive and time-consuming conventional toxicity tests;

3) to determine the toxicity of known toxicants using laboratory-prepared solutions of known concentrations; and

4) to compare Microxtox™ test results with those from other toxicity tests.

Microbiology Program

Microbiological monitoring includes both the maintenance of a small support laboratory for algal identifications and chlorophyll determinations, and the assessment of bacterial indicators of water pollution. The algal counts and chlorophyll results are measures of primary production and are used by the lake monitoring personnel to evaluate the trophic status of lakes and ponds. Data from riverine and coastal waters are used to identify those waterbodies subjected to nutrient enrichment and consequent algal and macrophyte growth. Algal indicators of the presence of elevated metals concentrations, nutrient enrichment, or other pollutants are noted in the interpretive report provided to the water quality analyst.

In the past two years, several bacteriological indicators including, but not limited to, the source differentiation of the fecal streptococci bacteria were used to assess water quality conditions and determine sources of fecal contamination in the North River, Agawam River, and Waquoit Bay on Cape Cod. Source differentiation of the fecal streptococci bacteria provides a means for determining the source of elevated bacteria counts. The kinds of sources that can be distinguished by this method are: insects, birds, warmblooded animals, and decaying vegetation. Identification of the type of source will aid in the establishment of mitigative measures for controlling nonpoint sources of fecal contamination.

8.6 Special Concerns and Recommendations

The following are the special concerns and recommendations for achieving CWA objectives including significant issues not discussed elsewhere in this report.

1. Widespread Contamination of Water Supplies

   The number of public water supply systems being closed due to contamination is increasing. In order to reverse this trend a complete inventory of tributaries to surface water supplies is needed. This will facilitate the application of strict antidegradation regulations to these waters. Antidegradation provisions need to be developed for ground water regulations and coordinated with surface water regulations. Beyond this, towns need to achieve better control over detrimental activities in the land areas surrounding wells, reservoirs and recharge areas; including the purchase of these areas for preservation.

2. Loss of Wetlands

   Valuable wetlands areas are decreasing in the state, but there is not systematic means of measuring these losses. A statewide wetland map should be developed to be used to determine the current status of wetlands. Critical wetland resources, such as recharge areas should be delineated for protection. Increased enforcement of existing wetlands regulations along with improved monitoring and analysis of wetlands replacement projects will help slow the rate of loss. However, these actions may not preclude the need for additional, more stringent, wetland regulations.

3. Coastal Water Quality Degradation

   Unlike other waterbody types, marine water quality has noticeably deteriorated over the last ten years. The exact extend of deterioration is not known because the monitoring program is inadequate. The assessment of these waters can be improved by segmenting the coast into study units, defining significant resources (such as shellfishing areas) and developing a systematic monitoring program for determining compliance with standards. Increased monitoring alone may result in a decrease in management closures of shellfish areas. Point source abatement measures, such as the cleanup of Boston Harbor must proceed. However, the downward trend indicates that more management of development in coastal areas along with the abatement of nonpoint sources of pollution will be necessary.

4. Prevention and Control of Nonpoint Sources

   Pollution due to point sources is rapidly being reduced in river waters. Point sources to marine waters are currently being addressed, and point sources to lakes and largely prohibited. The control of nonpoint sources of pollution is becoming the most important measure to achieve CWA objectives. Stormwater runoff and land disposal need to be examined for best management practices of pollution abatement. New methods of monitoring need to be developed in order to: 1) measure previously

unmonitored areas of the state for nonpoint source pollution; and 2) distinguish nonpoint source pollution from point source pollution. A policy for the regulation of stormwater needs to be developed.

5. Evaluation of Toxic Pollutants

Toxic pollutants affect many of our waterbodies. The exact nature and extent of the problem is not known because the monitoring program has been inconsistent. Parametric coverage has increased over the years and more sophisticated methods of analysis have improved detectability. Statewide toxic monitoring for all water body types needs to be implemented in a systematic manner. Chemical by chemical monitoring cannot succeed because of the seemingly limitless number of chemicals to be measured. Therefore a program of biological toxicity testing must be implemented to supplement chemical testing. In order to interpret results of monitoring, additional criteria are needed especially for sediments and fish flesh. The evaluation of toxicity must include three components: 1) human health; 2) aquatic life; and 3) bioaccumulation.

6. Threatened Lakes and Ponds

Most of the lake waters that currently meet water quality standards are perceived to be threatened. The causes are cultural eutrophication and acid precipitation. Cultural eutrophication must be controlled by comprehensive watershed management including public education, nonpoint source control and zoning laws. The only long term solution for acid precipitation is source control; lake liming is only an interim measure. Lakes that are currently polluted will be helped by increased attention to nonpoint source control, but reallocation of funding for the State Clean Lakes Program is also needed. Indications are that current subsurface disposal regulations are inadequate to protect lakes. Revised regulations and better enforcement of regulations are needed.

7. Treatment Facility Upgradings and O&M

Significant gains in water quality have been made through the construction of wastewater treatment facilities. It is essential that this investment be protected through the proper operation and maintenance of these facilities. Operator education programs and funding for maintenance and upgrading or rebuilding facilities are also needed.

8. Policy for Cleanup of Combined Sewer Overflows

Most of the major urban areas in Massachusetts have combined sewers. The construction of treatment plants for municipal point sources and the advent of best management practices for nonpoint sources leaves these significant sources of pollution unaddressed. Excessive costs may preclude the complete removal of CSO's in many areas. Therefore, a policy setting forth strict goals for levels of treatment is needed in order to achieve the highest water quality possible.

9. Contamination of Fish Flesh and Sediments

The historical pollution of certain waters has left a legacy of contaminated sediments/fish flesh. This type of pollution will not be remedied by the conventional means, i.e., the construction or upgrading of wastewater treatment plants. Therefore, further study is needed into the methods of abatement and the means of implementing these measures when the pollutor may no longer be present.

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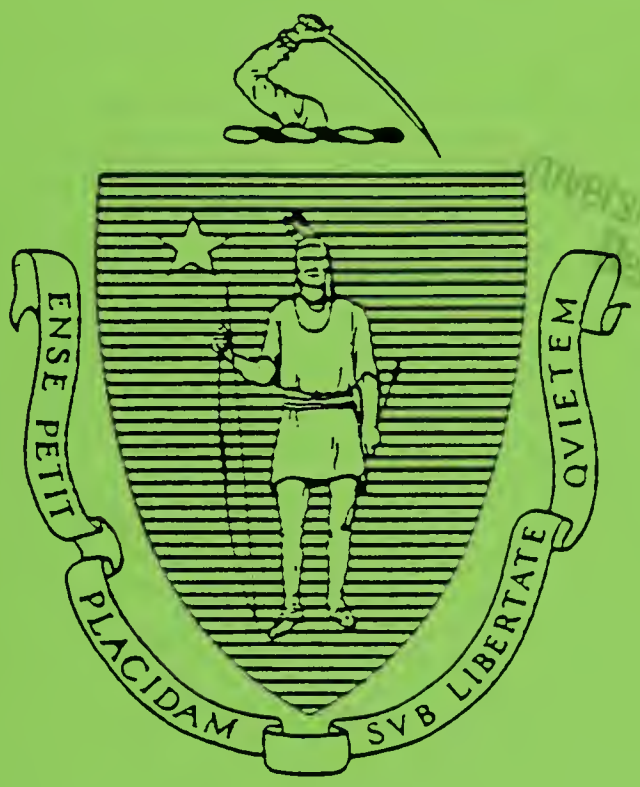
COMMONWEALTH OF MASSACHUSETTS
SUMMARY OF WATER QUALITY

1990



Appendix II - Massachusetts Lake Classification Program

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner
Arleen O'Donnell, Assistant Commissioner

DIVISION of WATER POLLUTION CONTROL

Brian M. Donahoe, Deputy Director

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COMMONWEALTH OF MASSACHUSETTS
SUMMARY OF WATER QUALITY

1990

APPENDIX II
MASSACHUSETTS LAKE CLASSIFICATION PROGRAM

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER POLLUTION CONTROL
TECHNICAL SERVICES BRANCH
WESTBOROUGH, MASSACHUSETTS

Executive Office of Environmental Affairs
John P. DeVillars, Secretary

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner
Arleen O'Donnell, Assistant Commissioner

Division of Water Pollution Control
Brian M. Donahoe, Deputy Director

June 1990

TITLE: Water Quality Assessment 1990
Appendix II
Massachusetts Lake Classification Program

DATE: May 1990

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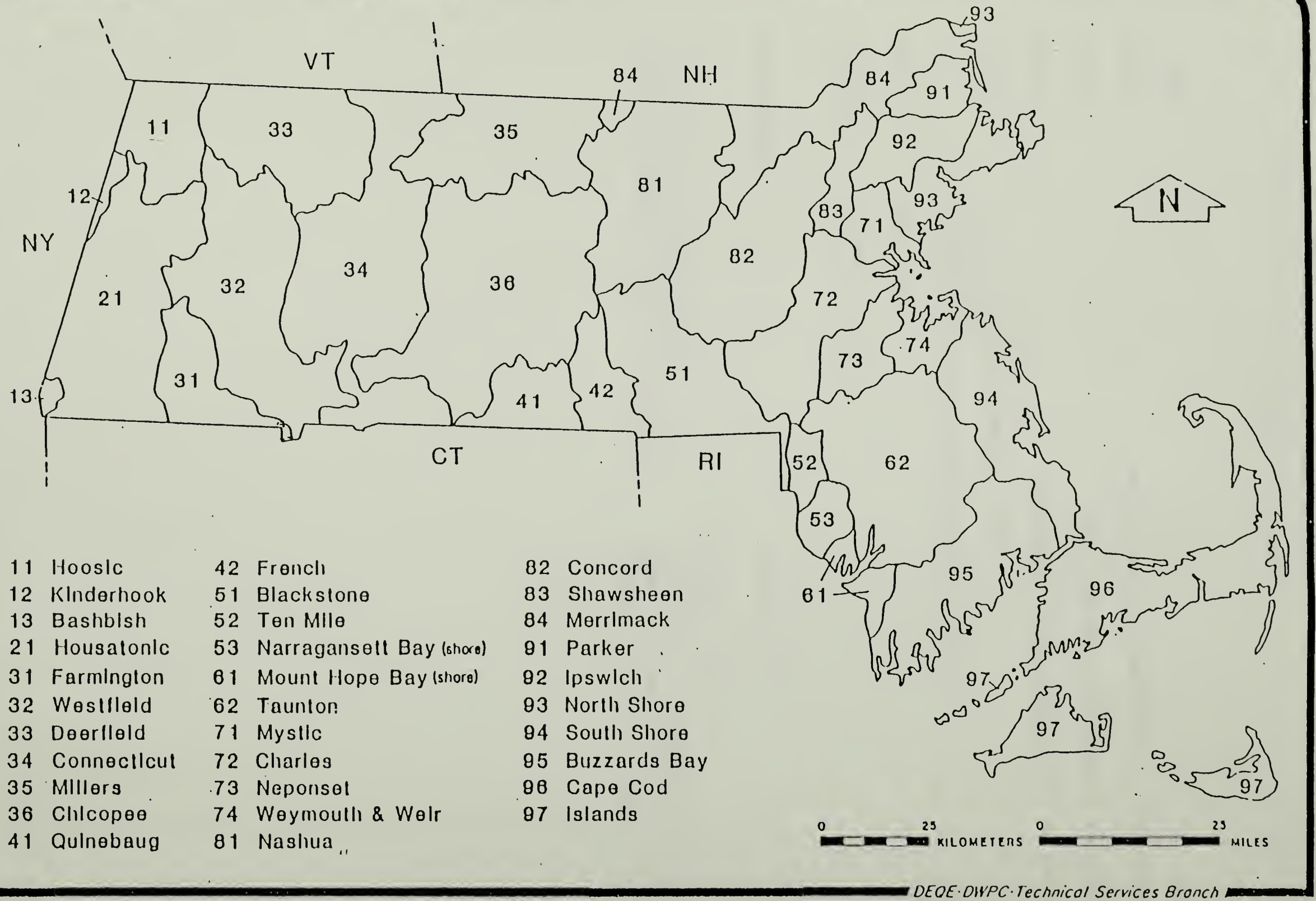

11	Hoosic	42	French	82	Concord
12	Kinderhook	51	Blackstone	83	Shawsheen
13	Bashbish	52	Ten Mile	84	Merrimack
21	Housatonic	53	Narragansett Bay (shore)	91	Parker
31	Farmington	61	Mount Hope Bay (shore)	92	Ipswich
32	Westfield	62	Taunton	93	North Shore
33	Deerfield	71	Mystic	94	South Shore
34	Connecticut	72	Charles	95	Buzzards Bay
35	Millers	73	Neponset	96	Cape Cod
36	Chicopee	74	Weymouth & Weir	97	Islands
41	Quinebaug	81	Nashua		

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Figure **A**

COMMONWEALTH OF MASSACHUSETTS
RIVER BASINS and COASTAL DRAINAGE AREAS

APPENDIX II

MASSACHUSETTS LAKE CLASSIFICATION PROGRAM

In accordance with Public Law 95-217, Section 314 (the "Clean Lakes" section of the 1977 Amendments to the Federal Water Pollution Control Act), the Massachusetts Division of Water Pollution Control developed a lake classification program based upon the trophic condition of all publicly owned freshwater lakes and ponds in the Commonwealth.

The Massachusetts Clean Lakes and Great Ponds Program was created under Chapter 628 of the Acts of 1981. An integral part of that program is the prioritization of publicly owned lakes and ponds for the purpose of providing financial assistance to municipalities for diagnostic-feasibility studies and implementation projects. The prioritization process is composed of several elements, one of which is the trophic status of lakes and ponds. The Division utilizes the Lake Classification Program as the basis for awarding priority points in the trophic status category.

A lake or pond is classified according to the system described in this report. The first step in this process is a baseline limnological survey of the lake or pond. This survey is generally conducted in one day and consists of bathymetric mapping of the lake; physical, chemical and biological sampling of the open water areas, tributary stream(s), and outlet; and a quantitative and qualitative mapping of the aquatic macrophyton community in the lake. The primary purpose of this survey is to classify the lake by its trophic status and identify any point and nonpoint sources of pollution. To date the Division has conducted 545 baseline surveys on waterbodies throughout the state.

Although a host of physical, chemical, and biological parameters are measured during the normal lake survey, only six critical parameters are employed in the lake classification priority system. The six parameters are hypolimnetic dissolved oxygen, secchi disc reading, phytoplankton count, total ammonia and nitrate-nitrogen, total phosphorus, and aquatic macrophyton. The most recent survey data are used and the priority listing is updated annually. The optimum season for collecting lake data is mid to late summer, or during peak biological production. Unfortunately, this cannot always be achieved, thus spring or autumnal data are occasionally used in the lake classification system.

The limits used for awarding severity points for the six parameters have been based on several considerations and information sources. These include lake classifications of other states, the natural range of parameters in Massachusetts, limnological texts, and accepted indices of eutrophication

reported in the literature. The severity point system has been formulated as follows:

PARAMETER	CONCENTRATION OR DEGREE OF SEVERITY	POINTS
Hypolimnetic dissolved oxygen	≥5.0 mg/l	0
	<5.0-3.0 mg/l	1
	<3.0-1.0 mg/l	2
	<1.0 mg/l	3
Transparency (secchi disc reading)*	≥15 feet (4.5 meters)	0
	<15-10 feet (4.5-3.0 meters)	1
	<10-4 feet (3.0-1.2 meters)	2
	<4 feet (1.2 meters)	3
Phytoplankton	0-500 cells/ml	0
	<500-1000 cells/ml	1
	<1000-1500 cells/ml	2
	<1500 cells/ml or summer "blooms"	3
Epilimnetic NH_3 + NO_3-N	0-<0.15 mg/l	0
	≥0.15-0.3 mg/l	1
	>0.3-0.5 mg/l	2
	>0.5 mg/l	3
Epilimnetic total phosphorus	0-0.01 mg/l	0
	>0.01-0.05 mg/l	1
	>0.05-0.10 mg/l	2
	>0.10 mg/l	3
Aquatic Vegetation	Sparse	0
	Medium	1
	Dense	2
	Very Dense	3

It is expected that chlorophyll a data will soon augment or replace the phytoplankton data as they become part of the routine lake survey. The severity points may be interpreted as follows:

0 = No problem - considered to be representative of clean water quality.

1 = Slight problem - borderline case considered to be potentially degrading.

2 = Definite problem - considered unacceptable for lake water quality.

3 = Severe problem - undoubtedly causing degradation of the lake's water quality or some recreational uses.

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* Four feet is the minimum allowable transparency at bathing beaches, as stated in Article VII of the State Sanitary Code.

LISTING OF CLASSIFIED LAKES AND PONDS

CLASSIFIED LAKES AND PONDS

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Aldrich Lake†	66	Granby	Connecticut	S	12	1981	421655/723300
Althea Lake	38	Tyngsborough	Merrimack	S	11	1979	424007/712252
Alum Pond†	189	Sturbridge	Quinebaug	S	8	1980	420834/720714
Ames Pond	82	Tewksbury	Shawsheen	U	7	1974	423820/711335
Ames Long Pond†	65	Stoughton/Easton	Taunton	U	14	1987	420500/710702
Arcadia Lake†	40	Belchertown	Connecticut	U	6	1978	421818/722540
Lake Archer	79	Wrentham	Charles	S	9	1978	420411/712017
Ashfield Pond†	39	Ashfield	Deerfield	S	7	1986	423154/724803
Ashland Reservoir†	155	Ashland	Concord	S	5	1981	421422/712750
Ashmere Lake	217	Hinsdale/Peru	Housatonic	U	5	1983	422643/730502
Ashumet Pond†	203	Mashpee	Cape Cod	S	7	1980	413800/703200
Asnacomet Pond	127	Hubbardston	Chicopee	S	5	1989	422720/715900
Lake Attitash†	335	Amesbury/Merrimac	Merrimack	S	8	1985	425030/705805
Attleboro Gravel Pit #1	-	Attleboro	Ten Mile	U	4	1981	415750/711846
Attleboro Gravel Pit #2	-	Attleboro	Ten Mile	U	3	1981	415450/711852
Augmentation Pond	333	Westborough	Concord	S	14	1979	-
Babson Farm Quarry	-	Rockport	North Shore	S	10	1981	424123/703755
Baddacook Pond	76	Groton	Merrimack	S	7	1977	423708/713152
Baker Pond	28	Orleans	Cape Cod	S	5	1980	414600/700015
Baldpate Pond	55	Boxford	Parker	S	10	1981	414152/710010
Bare Hill Pond	316	Harvard	Nashua	U	11	1983	422930/713545

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Barrett Pond†	8	Leominster	Nashua	S	9	1984	-
Barrowsville Pond†	38	Norton	Taunton	U	13	1983	415705/711210
Bartholomew Pond	8	Peabody	North Shore	S	6	1983	423030/705800
Bartlett Pond†	45	Northborough	Concord	U	7	1982	421905/713707
Bartlett Pond†	32	Plymouth	South Shore	U	7	1986	415535/703330
Bearse Pond†	65	Barnstable	Cape Cod	U	5	1983	414035/702000
Beaver Lake	149	Ware	Chicopee	U	5	1974	421530/721820
Beaver Pond	14	Beverly	Ipswich	U	14	1987	423445/705140
Beck Pond†	40	Hamilton	North Shore	S	9	1987	423615/704925
Bell Pond	7	Worcester	Blackstone	U	6	1979	421618/714700
Bellevue Pond†	3	Medford	Mystic	U	12	1986	422553/710628
Bemis Pond†	15	Chicopee	Chicopee	U	10	1988	420847/723527
Bemis Road Pond†	14	Hubbardston	Chicopee	U	10	1979	422822/715715
Benton Pond†	63	Otis	Farmington	U	2	1979	421100/730252
Bents Pond†	9	Gardner	Millers	U	11	1979	423328/715907
Berkshire Pond†	22	Lanesborough	Hoosic	U	11	1981	423015/731148
Big Bearhole Pond†	37	Taunton	Taunton	U	8	1983	415150/705900
Big Pond†	331	Otis	Farmington	S	10	1979	421136/730230
Billington Sea	269	Plymouth	South Shore	U	11	1986	415600/704115
Black's Nook†	2.5	Cambridge	Mystic	U	12	1983	422320/710910
Blake's Pond	-	Mansfield	Taunton	U	9	1986	-
Bloody Pond	94	Plymouth	South Shore	S	5	1984	415100/703500

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Boons Pond (Lake Boon)†	175	Hudson/Stow	Concord	S	11	1980	422330/713000
Bourn-Hadley Pond	27	Templeton	Millers	U	7	1979	423322/720522
Bower Springs Conservation Area	11	Bolton	Nashua	U	8	1979	422752/713625
Box Pond†	46	Bellingham/Mendon	Charles	U	17	1988	420535/712930
Lake Bray†	12	Holyoke	Connecticut	U	6	1987	421605/723700
Brierly Pond	18	Millbury	Blackstone	U	9	1979	421037/714635
Brigham Pond†	45	Hubbardston	Chicopee	U	13	1979	422822/720000
Brockton Reservoir	89	Avon	Taunton	S	8	1975	420658/710318
Brookline Reservoir	18	Brookline	Charles	U	4	1988	421940/710815
Brooks Pond†	190	Spencer/Oakham New Braintree/ N. Brookfield	Chicopee	S	7	1983	421800/720230
Browning Pond†	106	Oakham/Spencer	Chicopee	S	7	1987	421850/715953
Browns Pond†	26	Peabody	North Shore	S	7	1983	423000/705715
Buck Hill Pond	-	Spencer	Chicopee	U	11	1987	-
Buck Pond†	25	Westfield	Westfield	S	11	1978	421015/724212
Buckley-Dunton Lake†	195	Becket	Westfield	U	7	1978	421830/730515
Lake Buel†	194	Monterey/New Marlborough	Housatonic	S	10	1976	421010/731630
Buffumville Lake	186	Charlton/Oxford	French	S	8	1976	420708/715439
Bullough's Pond†	6	Newton	Charles	U	12	1984	422023/711222
Burr's Pond†	5	Seekonk	Narragansett Bay	S	15	1983	414920/712015

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Buttonwood Park Pond†	12	New Bedford	Buzzards Bay	U	9	1984	413600/705740
Cain Pond†	4	Taunton	Taunton	S	12	1987	415130/705845
Camp Putnam Pond	-	New Braintree	Chicopee	U	4	1976	421922/720112
Candlelight Pond†	8	Templeton	Millers	U	6	1979	-
Card Pond†	12	West Stockbridge	Housatonic	U	4	1978	421935/732200
Carding Mill Pond†	40	Sudbury	Concord	U	13	1979	422142/712758
Cedar Lake†	21	Falmouth	Cape Cod	U	4	1980	413855/703725
Cedar Pond†	146	Sturbridge	Quinebaug	U	12	1989	420730/720525
Cedar Swamp Pond†	95	Milford	Charles	U	**	1986 D/F	420910/713055
Center Pond†	125	Becket	Westfield	S	5	1978	421755/730410
Center Pond†	30	Dalton	Housatonic	U	5	1976	422838/730915
Central Pond†	139	Seekonk/Pawtucket/ E. Providence, RI	Ten Mile	U	13	1984	415130/712025
Chaffins Pond	104	Holden	Nashua	U	5	1977	421952/715028
Chandler Pond†	11	Boston	Charles	U	14	1983	422040/711000
Chartley Pond†	38	Norton/Attleboro	Taunton	U	13	1980	415651/711400
Chase Pond	-	Fall River	Taunton	U	13	1983	414130/710830
Chauncy Lake†	177	Westborough	Concord	S	6	1974	421737/713648
Chebacco Lake†	209	Hamilton/Essex	North Shore	S	10	1980	423645/704830
Cheshire Reservoir†	418	Cheshire/ Lanesborough	Hoosic	U	7	1980	423200/731130
Chicopee Falls Impoundment	-	Chicopee	Chicopee	U	11	1980	420938/723407

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Clapps Pond†	40	Provincetown	Cape Cod	U	12	1980	420310/701230
Clara Barton Pond	-	Oxford	French	S	9	1982	420913/715343
Clark Pond†	6	Walpole	Neponset	U	10	1984	420817/711432
Cleveland Pond†	88	Abington	Taunton	U	12	1980	420715/705855
Cliff Pond	193	Brewster	Cape Cod	S	7	1980	414530/710030
Cobbs Pond†	24	Walpole	Neponset	S	9	1984	420938/711443
Lake Cochituate† (Carling, Middle North Basins)	361	Framingham/ Natick/Wayland	Concord	S	12	1980	421805/712210
Lake Cochituate† (South Basin)	233	Natick	Concord	S	10	1980	421725/712210
Coes Reservoir†	90	Worcester	Blackstone	U	10	1977	421515/715034
Comins Pond†	23	Warren	Chicopee	U	5	1983	421212/721147
Congamond Lakes (Middle)†	267	Southwick	Westfield	S	13	1978	420135/724524
Congamond Lakes (North)†	48	Southwick	Westfield	S	12	1978	420240/724508
Congamond Lakes (South)†	135	Southwick	Westfield	S	13	1978	420153/724552
Cook Pond†	154	Fall River/ Tiverton, RI	Mount Hope Bay	S	12	1983	414030/711030
Cook Pond†	20	Worcester	Blackstone	U	10	1986	421707/715130
Cooley Lake†	91	Granville	Westfield	U	8	1979	420322/725105
Cow Pond	38	Groton	Nashua	S	7	1979	423620/713050
Coy Pond†	25	Wenham	North Shore	U	9	1983	423030/704915

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Crackrock Pond	14	Foxborough	Neponset	U	13	1984	420500/711520
Cranberry Pond	5	Braintree	Weymouth & Weir	U	7	1981	421015/705932
Cranberry Pond†	8	Tolland	Farmington	S	8	1979	420350/730015
Cranberry Meadow Pond†	63	Spencer/Charlton	Chicopee	U	4	1984	421113/720010
Cross Pond†	2	Brockton	Taunton	U	9	1989	420525/710232
Crystal Lake	90	Douglas	Blackstone	U	8	1977	420250/714607
Crystal Lake	36	Orleans	Cape Cod	S	7	1982	414630/695900
Curtis Pond†	18	Worcester	Blackstone	U	10	1985	421443/715027
Damon Pond†	88	Chesterfield/ Goshen	Westfield	U	9	1980	422504/725000
Dark Brook Reservoir†	57	Auburn	Blackstone	U	10	1982	421115/715200
Davenport Pond†	-	Athol/Petersham	Millers	U	9	1982	423237/721207
Davidson Park Pond	-	Winchester	Mystic	U	10	1985	-
Dean Pond†	12	Brimfield/Monson	Chicopee	S	9	1984	420605/721610
Deerfield Pond†	0.2	Medway	Charles	U	14	1989	-
Lake Denison†	82	Winchendon	Millers	U	9	1984	423837/720520
Depot (Long) Pond†	25	Eastham	Cape Cod	S	2	1980	414952/695850
Diamond International Impoundment	105	Palmer	Chicopee	U	13	1985	421136/721933
Diamond Pond†	7	Walpole	Neponset	U	13	1988	420844/711452
Dimmock Pond†	11	Springfield	Chicopee	U	8	1978	420855/722928

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Dodgeville Pond†	47	Attleboro	Ten Mile	U	11	1984	415535/711726
Dorothy Pond†	148	Millbury	Blackstone	U	13	1987	421257/714504
Dudley Pond†	84	Wayland	Concord	S	10	1988	421945/712215
Dug Pond†	49	Natick	Charles	S	5	1985	421635/712155
Dunns Pond†	18	Gardner	Millers	S	4	1985	423430/715817
Dutton Pond†	6	Leicester	French	U	11	1987	421408/715515
Eagle Lake†	84	Holden	Nashua	U	6	1980	422121/715308
Eames Pond†	74	Paxton	Chicopee	S	8	1984	421845/715720
East Brimfield Reservoir	420	Brimfield/ Sturbridge	Quinebaug	U	7	1976	420627/720840
East Head Pond	-	Carver	Buzzards Bay	U	8	1989	-
East Indies Pond	69	New Marlborough	Housatonic	U	3	1978	420350/731135
East Waushacum Pond†	188	Sterling	Nashua	S	7	1989	422445/714500
Echo Lake	123	Hopkinton/Milford	Charles	S	3	1978	421137/713045
Eddy Pond†	134	Auburn	Blackstone	U	8	1977	421038/715037
Edgartown Great Pond†*	911	Edgartown	Islands	U	**	1987	412115/70330
Ell Pond†	23	Melrose	Mystic	S	10	1981	422737/710355
Ezekiel Pond	36	Plymouth	Buzzards Bay	U	2	1987	415433/704245
Lake Elizabeth†	7	Barnstable	Cape Cod	U	11	1982	413825/702000
Lake Ellis†	67	Athol	Millers	U	9	1979	423430/721222

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Evergreen Cemetery Pond	1	Medway	Charles	U	10	1985	-
Factory Hollow Pond (Puffers Pond)†	8	Amherst	Connecticut	U	6	1984 D/F	422455/723110
Factory Pond†	45	Hanover/Hanson	South Shore	U	12	1980	420525/705230
Falls Pond†	60	North Attleborough	Ten Mile	S	14	1984	415810/711925
Farm Pond	124	Sherborn	Charles	S	6	1983	421400/712045
Farmers Pond†	9	Attleboro	Ten Mile	U	14	1984	415709/711807
Farrar Pond†	126	Lincoln	Concord	U	5	1986	422450/712116
Fawn Lake†	11	Bedford	Shawsheen	U	7	1985 D/F	423050/711625
Fivemile Pond†	36	Springfield	Chicopee	S	6	1978	420830/723040
Flannagan (Fletcher) Pond†	87	Ayer	Nashua	U	13	1980	423325/713415
Flax Pond†	19	Bourne	Cape Cod	U	5	1980	414120/703540
Flax Pond	16	Dennis	Cape Cod	S	1	1980	414250/701115
Flax Pond†	49	Lynn	North Shore	S	11	1986	422855/705710
Flint Pond (North & South)†	297	Grafton/Shrewsbury	Blackstone	U	9	1977	421500/714413
Flint Pond†	61	Tyngsborough	Merrimack	U	12	1989	424022/712600
Floating Bridge Pond†	10	Lynn	North Shore	U	9	1986	422908/705672
Flushing Pond	18	Westford	Merrimack	S	7	1974	423721/712630
Forest Lake†	55	Methuen	Merrimack	S	9	1986	424340/711452
Forge Pond†	68	Granby	Connecticut	U	12	1981	421622/722807
Forge Pond	20	Hanover	South Shore	U	16	1980	420622/705252

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Forge Pond†	198	Westford/Littleton	Merrimack	S	11	1974	423434/712924
Fort Meadow Reservoir†	284	Hudson/Marlborough	Concord	S	9	1979	422200/713300
Fort Pond†	78	Lancaster	Nashua	S	6	1987	423026/712800
Fort Pond	100	Littleton	Concord	S	10	1980	423025/712800
Fosters Pond	135	Andover/Wilmington	Shawsheen	S	12	1974	423622/710817
Foundry Pond†	8	Hingham	Weymouth & Weir	U	12	1985	421415/705143
Fourmile Pond	25	Boxford	Ipswich	S	5	1987	424108/710044
Fresh Pond	29	Dennis	Cape Cod	U	7	1980	414045/703910
Fresh Pond†	62	Plymouth	South Shore	S	9	1985	415415/703320
Frye Pond†	7	Haverhill	Merrimack	U	7	1983	424820/710500
Fuller Pond†	4	Plainville	Ten Mile	U	10	1978	420047/712058
Furnace Pond†	100	Pembroke	South Shore	U	6	1980	420320/704935
Gallows Pond†	43	Plymouth	Buzzards Bay	S	6	1984	415145/703700
Lake Garfield†	262	Monterey	Housatonic	S	9	1986	421106/731150
Lake George†	93	Wales	Quinebaug	S	8	1976	420330/721252
Glen Charlie Pond†	185	Wareham	Buzzards Bay	U	5	1985	414730/703849
Glen Echo Lake	116	Charlton	Quinebaug	S	11	1984	420949/715933
Goodrich Pond†	13	Pittsfield	Housatonic	S	14	1978	422654/731315
Goose Pond†	34	Chatham	Cape Cod	S	5	1980	414140/700025
Goose Pond	225	Lee/Tyringham	Housatonic	S	2	1976	421650/731145
Gore Pond†	169	Charlton/Dudley	French	S	12	1984	420451/715649
Granite Reservoir	198	Charlton	French	U	4	1974	420600/715600

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Great Herring Pond†	376	Plymouth/Bourne	South Shore	S	9	1981	414800/703400
Great Pond†	110	Eastham	Cape Cod	S	7	1982	415000/695930
Great Pond	17	Truro	Cape Cod	S	7	1986	-
Green Hill Pond	32	Worcester	Blackstone	U	7	1977	421700/714652
Greenes Pond	10	Fitchburg	Nashua	U	11	1979	423622/714807
Greenville Pond†	30	Leicester	French	U	13	1987	421223/715522
Greenwater Pond	88	Becket	Housatonic	S	3	1978	421705/730900
Gristmill Pond†	16	Sudbury	Concord	U	15	1988	422118/721848
Griswold Pond†	13	Saugus	North Shore	U	7	1985	422838/710302
Grove Pond†	67	Ayer	Nashua	S	11	1984	423310/713505
Gull Pond	109	Wellfleet	Cape Cod	S	5	1988	415725/700030
Hager Pond†	28	Marlborough	Concord	U	12	1979	422059/712916
Halfway Pond†	232	Plymouth	South Shore	U	7	1984	415110/703700
Halls Pond†	2	Brookline	Charles	S	13	1983	422046/710645
Hamblin Pond†	149	Barnstable	Cape Cod	S	10	1985	415004/702435
Hamilton Reservoir†	249	Holland/Union, CT	Quinebaug	U	12	1982 D/F	420407/720914
Hammond Pond†	37	Goshen	Westfield	U	10	1978	422442/724800
Hammond Pond†	21	Newton	Charles	U	10	1988	421928/711015
Harbor Pond†	42	Townsend	Nashua	U	8	1984	423907/714040
Hardwick Pond†	68	Hardwick	Chicopee	S	13	1981	421845/721425
Hardy Pond†	41	Waltham	Charles	U	12	1978	422430/711433
Harris Pond†	93	Blackstone	Blackstone	S	11	1988	420058/713030

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Harris Pond†	12	Ludlow	Chicopee	U	11	1979	421040/722935
Haviland Pond†	25	Ludlow	Chicopee	S	7	1987	421022/722830
Hayden Pond	41	Dudley	French	S	4	1987	420433/715509
Heard Pond†	71	Wayland	Concord	U	11	1987	422110/712300
Heart Pond	91	Chelmsford	Concord	S	7	1979	423355/412315
Hebronville Pond	16	Attleboro	Ten Mile	U	12	1984	415438/711911
Herring Pond†	43	Eastham	Cape Cod	S	9	1979	414930/695910
Highland Lake†	15	Norfolk	Charles	S	14	1978	420734/711822
Hills Pond†	-	Arlington	Mystic	U	8	1980	422440/710955
Hinckleys Pond†	171	Harwich	Cape Cod	S	8	1980	414250/700530
Hobart Pond†	15	Whitman	Taunton	U	14	1981	420507/705545
Hobomock Pond†	15	Pembroke	South Shore	U	10	1985	420325/704835
Hocomonco Pond	27	Westborough	Concord	U	8	1974	421621/713900
Lake Holbrook†	32	Holbrook	Weymouth & Weir	U	12	1983	420835/710115
Holland Lake†	12	Belchertown	Connecticut	S	8	1978	421850/722555
Holland Pond†	65	Holland	Quinebaug	S	5	1976	420445/720955
Hood Pond	67	Topsfield/Ipswich	Ipswich	S	6	1979	424222/705640
Hoosicwhisick Pond†	23	Milton	Weymouth & Weir	S	8	1985	421227/710545
Hopkinton Reservoir†	170	Ashland/Hopkinton	Concord	S	7	1988	421525/713045
Horn Pond†	104	Woburn	Mystic	S	10	1983	422807/710922
Horse Pond†	30	Westfield	Westfield	U	5	1978	421034/724152
Houghton Pond†	17	Holliston	Charles	U	13	1978	421247/721545

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Howe Pond†	11	Spencer	Chicopee	S	8	1984	421247/715957
Hoxie Pond†	9	Sandwich	Cape Cod	S	11	1980	414350/702605
Ice House Pond	-	Shirley	Nashua	U	8	1982	423305/713725
Indian Lake†	190	Worcester	Blackstone	S	9	1976	421752/714845
Ingraham Brook Pond†	5	Granby	Connecticut	U	9	1988	-
Island Grove Pond†	38	Abington	Taunton	U	13	1983	420638/705628
Jacobs Pond†	59	Norwell	South Shore	U	8	1979	420943/705058
Jamaica Pond†	63	Boston	Charles	S	4	1988	421900/710715
Jennings Pond†	10	Natick	Charles	U	12	1982	421807/711945
Johns Pond†	323	Mashpee	Cape Cod	S	10	1980	413739/703114
Johnsons Pond†	180	Groveland/Boxford	Merrimack	S	6	1983	424300/710315
Jordan Pond†	20	Shrewsbury	Blackstone	U	11	1977	421605/714448
Judkins Pond†	6	Winchester	Mystic	U	9	1985	422716/710808
Kendall Pond†	23	Gardner	Millers	S	7	1985	423345/720107
Keyes Pond	40	Westford	Merrimack	S	9	1974	423652/712752
Lackey Pond†	117	Uxbridge/Sutton	Blackstone	U	12	1977	420543/714125
Lagoon Pond†	535	Oak Bluffs/Tisbury	Islands	U	5	1983	412630/703548
Lake Lashaway	270	East Brookfield/ North Brookfield	Chicopee	S	8	1988	421410/720250
Larner Pond†	25	Dudley	French	S	9	1987	-
Laurel Lake†	51	Erving/Warwick	Millers	S	6	1985	423715/722215
Laurel Lake†	165	Lee/Lenox	Housatonic	S	8	1976	421930/731615

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Leach Pond†	102	Easton/Sharon	Taunton	U	7	1984	420355/710920
Leadmine Pond	62	Sturbridge	Quinebaug	S	2	1976	420348/720730
Learned Pond†	34	Framingham	Concord	U	6	1986	421714/712512
Leverett Pond	7	Brookline/Boston	Charles	U	9	1978	421940/710645
Leverett Pond†	65	Leverett	Connecticut	U	6	1978	422725/723053
Little Pond	16	Bolton	Concord	U	2	1979	422525/713915
Little Alum Pond	73	Brimfield	Quinebaug	S	6	1986	420750/720908
Little Fresh Pond	-	Cambridge	Mystic	U	9	1983	422305/710920
Little Harbor Pond*	-	Cohasset	South Shore	-	-	1986	421500/704810
Little Long Pond	45	Plymouth	Buzzards Bay	U	6	1984	415210/703650
Little Nugget Lake	14	Charlton	French	S	8	1984	421018/715700
Little Sandy Bottom Pond†	62	Pembroke	South Shore	U	7	1985	420230/704957
Little Sandy Pond	29	Plymouth	Buzzards Bay	U	1	1987	-
Little West Pond†	25	Plymouth	Buzzards Bay	U	8	1987	415517/704224
Long Pond	44	Ayer	Nashua	S	12	1984	423415/713224
Long Pond†	88	Littleton	Concord	S	9	1986	423030/712815
Long Pond†	49	Barnstable	Cape Cod	U	7	1983	414000/702640
Long Pond†	166	Dracut/ Tyngsborough	Merrimack	U	8	1983	424130/712215
Long Pond†	18	Springfield	Chicopee	U	12	1987	420915/723037
Long Pond†	39	Tewksbury	Shawsheen	U	15	1989	423552/711508
Long Pond†	33	Wellfleet	Cape Cod	S	2	1980	415640/700030

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Long Pond†	59	Yarmouth	Cape Cod	S	12	1986 D/F	414010/701153
Long Southt-for Pond	106	Westford	Merrimack	S	6	1974	423715/712710
Loon Pond†	29	Springfield	Connecticut	U	6	1978	420837/723000
Lost Pond	2	Brookline	Charles	U	12	1978	421852/711030
Lost Lake/Knops Pond†	204	Groton	Merrimack	S	7	1978	423518/713126
Lake Lorraine†	27	Springfield	Chicopee	S	7	1978	420845/723050
Louisa Lake†	19	Milford	Charles	U	8	1985	420922/713120
Lout Pond†	18	Plymouth	South Shore	S	4	1985	415607/704015
Lowe Pond†	32	Boxford	Ipswich	U	5	1978	424035/705908
Lower Chandler Pond†	30	Duxbury	South Shore	S	14	1989	420152/704545
Lower Highland Lake	88	Goshen	Connecticut	U	2	1985	422652/724755
Lower Mill Pond†	29	Brewster	Cape Cod	U	10	1987	-
Lower Mill Pond†	32	Easthampton	Connecticut	U	10	1978	421620/723930
Lower Mystic Lake	111	Arlington/Medford	Mystic	S	15	1978	422535/710850
Lower Naukeag Lake†	260	Ashburnham	Millers	U	6	1979	424000/715230
Lower Pond†	19	Saugus	North Shore	U	8	1985	422920/710212
Lower Pond†	6	South Hadley	Connecticut	S	5	1984	421515/723423
Manchaug Pond	348	Douglas/Sutton	Blackstone	S	3	1977	420600/714637
Lake Mansfield†	25	Great Barrington	Housatonic	U	8	1986	421210/732205
Maquan Pond†	45	Hanson	South Shore	U	7	1982	420345/703730
Mare Pond†	14	Plymouth	South Shore	U	5	1982	414622/703730
Martins Pond†	92	North Reading	Ipswich	U	10	1981	423545/710730

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Lake Mascuppic†	209	Dracut/ Tyngsborough	Merrimack	S	14	1981	424037/712300
Mashpee Pond†	378	Mashpee	Cape Cod	S	7	1986	413940/702910
Lake Massapoag	113	Dunstable/Groton/ Tyngsborough	Merrimack	S	8	1989	423900/712945
Massapoag Pond†	353	Sharon	Neponset	S	7	1977	420615/711037
Matfield Impoundment	-	East Bridgewater	Taunton	U	13	1986	-
Lake Mattawa†	112	Orange	Chicopee	S	7	1989	423400/721922
McTaggart's Pond	9	Fitchburg	Nashua	U	7	1979	423440/715045
Mechanics Pond†	9	Attleboro	Ten Mile	U	14	1984	415654/711743
Memorial Park Pond	-	Taunton	Taunton	U	13	1983	415325/710535
Merino Pond†	72	Dudley	French	U	5	1987	420302/715406
Metacomet Lake†	74	Belchertown	Connecticut	U	7	1978	421822/722555
Mill Pond†	34	Littleton	Merrimack	U	12	1987	423210/713008
Mill Pond†	107	Sheffield	Housatonic	U	7	1986	420713/732147
Mill Pond†	150	Wareham	Buzzards Bay	U	9	1989	414645/704030
Mill Pond†	16	West Newbury	Merrimack	S	11	1983	424815/705315
Mill Pond†	2	Winchester	Mystic	U	8	1985	422707/710808
Minechoag Pond†	21	Ludlow	Chicopee	U	9	1987	420945/722735
Lake Mirimichi†	170	Plainville/ Foxborough	Taunton	S	**	1986	420135/711738
Mirror Lake†	7	Fitchburg	Nashua	U	8	1979	423337/714805
Mirror Lake†	55	Wrentham/Norfolk	Charles	U	8	1989	420517/711932

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Mona Lake	11	Springfield	Chicopee	S	15	1987	420835/723115
Lake Monomonac	592	Winchendon/ Rindge, NH	Millers	U	7	1976	424250/720030
Monponsett Pond (East)†	246	Halifax	Taunton	U	7	1982	420015/705015
Monponsett Pond (West)†	282	Halifax/Hanson	Taunton	U	13	1982	420030/705045
Moores Pond†	31	Warwick	Millers	S	3	1987	423922/722052
Morses Pond†	116	Wellesley/Natick	Charles	S	12	1983	421755/711910
Mossy Pond	28	Clinton	Nashua	S	8	1977	422506/714204
Muddy Pond†	64	Carver	Taunton	U	9	1987	415447/704719
Mumford Pond	9	Douglas	Blackstone	U	6	1984	420430/713712
Murphy Pond†	8	Ludlow	Chicopee	U	10	1982	421017/722937
Musquashcut Pond†	71	Scituate	South Shore	U	12	1983	421345/704540
Nabnasset Pond	115	Westford	Merrimack	U	7	1977	423700/712530
Nashawannuck Pond†	22	Easthampton	Connecticut	S	11	1981	421540/724000
Neponset Reservoir†	268	Foxborough	Neponset	U	11	1986	420505/711445
New Long Pond†	23	Plymouth	Buzzards Bay	U	9	1984	415110/704045
Nine Mile Pond†	32	Wilbraham	Chicopee	S	10	1978	420852/722607
Nipmuc Pond	85	Mendon	Blackstone	S	6	1977	420545/713415
Nippenicket Lake	354	Bridgewater	Taunton	U	7	1975	415815/710230
Noannet Pond†	58	Westwood/Dover	Charles	U	5	1985	-
Lake Noquochoke	124	Dartmouth	Buzzards Bay	S	13	1979	413900/710230
North Pond†	260	Hopkinton/Milford	Blackstone	S	11	1984 D/F	421055/713345

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
North Spectacle Pond†	30	New Salem	Millers	S	9	1979	423115/721610
North Watuppa Pond	1700	Fall River/ Westport	Mount Hope Bay	U	2	1980	414230/710615
Norton Reservoir†	529	Mansfield/Norton	Taunton	U	9	1987	415906/711204
Norwich Pond†	122	Huntington	Westfield	S	9	1978	421823/724957
Noyes Pond	166	Tolland	Farmington	U	3	1979	420622/730136
Nutting Lake†	78	Billerica	Concord	U	14	1985	423210/711615
Nye Pond†	6	Sandwich	Cape Cod	S	6	1989	414338/702558
Oakland Pond†	40	Taunton	Taunton	U	12	1988	-
Oldham Pond†	235	Pembroke	South Shore	U	6	1980	420405/705009
Onota Lake†	617	Pittsfield	Housatonic	S	4	1976	422815/731652
Orange Impoundment	-	Orange	Millers	U	14	1987	423522/721822
Otis Reservoir	1200	Otis	Farmington	S	5	1979	420930/730230
The Oxbow†	212	Northampton	Connecticut	U	16	1978	421730/723800
Packard Pond†	34	Orange	Millers	S	7	1979	423800/721400
Palmer Reservoir, North (Graves Brook Reservoir, North)	-	Palmer	Chicopee	S	4	1984	420943/721840
Palmer Reservoir, South (Graves Brook Reservoir, South)	-	Palmer	Chicopee	S	6	1984	-
Parker Pond†	26	Gardner	Millers	U	11	1986	421610/715108
Park Pond	-	Medway	Charles	U	15	1984	420850/712543

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Partridge Pond†	23	Westminster	Nashua	U	9	1979	423215/712625
Partridgeville Pond†	39	Templeton	Millers	U	6	1979	423245/720245
Patch Pond	3	Worcester	Blackstone	U	8	1979	421552/715100
Patch Reservoir†	31	Worcester	Blackstone	S	11	1986	423445/720043
Patch Pond	3	Worcester	Blackstone	U	8	1979	421552/715100
Patch Reservoir†	31	Worcester	Blackstone	S	11	1986	421610/715108
Lake Pearl†	218	Wrentham	Charles	S	11	1989	420350/712107
Pelham Lake†	71	Rowe	Deerfield	U	10	1977	424200/725322
Pentucket Pond†	85	Georgetown	Parker	S	11	1983	424403/705950
Pepperell Pond	-	Pepperell	Nashua	U	15	1981	423845/713500
Pequot Pond†	154	Westfield	Westfield	S	4	1978	421105/724140
Peter Pond†	44	Dudley	French	S	10	1987	420345/715345
Peters Pond	77	Dracut	Merrimack	S	11	1979	424300/711537
Pierce Pond†	25	Leominster	Nashua	U	4	1986	423250/714700
Pierpoint Meadow Pond†	90	Charlton/Dudley	French	U	7	1989	420505/715459
Pilgrim Lake†	39	Orleans	Cape Cod	S	5	1980	414552/695845
Pillings Pond	96	Lynnfield	North Shore	U	13	1977	423145/710145
Pinewood Pond†	21	Stoughton	Neponset	U	7	1987	420746/710825
Plainfield Pond†	57	Plainfield	Deerfield	U	3	1977	423230/725730
Plunkett Reservoir	73	Hinsdale	Housatonic	S	3	1976	422530/730742
Pomps Pond†	14	Andover	Shawsheen	U	13	1987	420007/710905
Pondville Pond†	41	Auburn/Millbury	Blackstone	U	11	1977	421127/714900

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Pontoosuc Lake†	467	Pittsfield/ Lanesborough	Housatonic	S	11	1976	422930/731500
Populatic Pond	40	Norfolk	Charles	U	10	1987	420749/712250
Porter Lake†	28	Springfield	Connecticut	U	15	1979	420622/723352
Powder Mill Pond	40	Acton	Concord	U	12	1989	-
Powissett Pond	6	Westwood/Dover	Charles	U	8	1985	421400/711453
Pratt Pond†	38	Upton	Blackstone	S	9	1989	421055/713600
Prindle Lake†	71	Charlton	Quinebaug	U	8	1983	420645/715945
Prospect Lake†	55	Egremont	Housatonic	U	6	1985	421145/732708
Putnam Pond	4	Fitchburg	Nashua	U	10	1979	423550/714715
Quaboag Pond†	531	Brookfield/ East Brookfield	Chicopee	U	8	1980	421148/720410
Quacumquasit Pond†	218	Brookfield/ East Brookfield/ Sturbridge	Chicopee	S	6	1975	421021/720422
Lake Quannapowitt†	254	Wakefield	North Shore	U	11	1986 D/F	423053/710440
Queen Lake†	138	Phillipston	Chicopee	U	1	1979	423200/720700
Queen Sewell Pond	18	Bourne	Cape Cod	U	2	1980	414520/703615
Lake Quinsigamond†	475	Worcester/ Shrewsbury	Blackstone	S	11	1980	421626/714522
Ramshorn Pond	117	Millbury/Sutton	Blackstone	S	3	1977	420915/714830
Red Bridge Impoundment	83	Ludlow/Wilbraham/ Palmer	Chicopee	S	9	1985	421052/722408
Red Lily Pond†	4	Barnstable	Cape Cod	U	12	1982	414325/701955

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
The Reservoir	7	Harwich	Cape Cod	U	9	1980	-
Rice City Pond	91	Uxbridge	Blackstone	U	15	1985	420550/713724
Richards Reservoir†	30	Warwick	Millers	U	10	1987	424151/721910
Richmond Pond†	218	Pittsfield/ Richmond	Housatonic	S	5	1976	422456/731930
Lake Ripple†	63	Grafton	Blackstone	U	9	1986 D/F	421235/714155
Riverdale Impoundment (New dam has increased area)	18	Northbridge	Blackstone	S	13	1985	420820/713827
Robbins Pond	124	East Bridgewater	Taunton	U	5	1975	420015/705428
Robinson Pond†	6	Mansfield	Taunton	U	9	1986	420012/711547
Robinson Pond†	98	Oxford	French	U	4	1976	420620/714948
Rochdale Pond†	41	Leicester	French	S	8	1987	421152/715430
Rock Pond†	42	Georgetown	Parker	S	12	1983	424343/710020
Rockwell Pond	10	Leominster	Nashua	U	8	1977	423139/714607
Rocky Pond	60	Boylston	Concord	S	2	1974	422047/714119
Lake Rohunta† (Eagleville Pond)	250	Athol/Orange/ New Salem	Millers	S	10	1981	423300/721622
Rosemary Lake	12	Needham	Charles	U	10	1979	421710/711420
Round Pond	10	Plymouth	Buzzards Bay	U	5	1984	415136/703618
Rubber Thread Pond	-	Easthampton	Connecticut	U	11	1978	421552/724022
Rudd Pond	80	Becket	Westfield	S	6	1978	421745/730453
Ruggles Pond†	19	Wendell	Millers	U	9	1984	423253/722653

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Russell Pond†	85	Russell	Westfield	S	8	1978	420919/725158
Ryder Pond	18	Truro	Cape Cod	S	5	1986	415800/700155
Lake Sabbatia†	237	Taunton	Taunton	S	11	1980	415640/710627
Salisbury Pond†	17	Worcester	Blackstone	U	16	1983	421636/714823
Salt Pond*	62	Falmouth	Cape Cod	S	12	1980	413235/703735
Lake Samoset†	44	Leominster	Nashua	S	8	1983	422930/714540
Sandy Pond	74	Ayer	Nashua	S	6	1980	423342/713322
Sandy Pond†	162	Lincoln	Charles	S	9	1989	422606/711856
Santuit Pond†	172	Mashpee	Cape Cod	U	13	1987	413915/702730
Sargent Pond	2	Brookline	Charles	U	10	1982	421915/710741
Sargent Pond†	69	Leicester	French	U	6	1987	421455/715500
Sassaquin Pond	34	New Bedford	Buzzards Bay	S	5	1980	414406/705659
Sawdy Pond	363	Westport/ Tiverton, RI/ Fall River	Mount Hope Bay	U	3	1983	413700/710815
Sawmill Pond†	61	Fitchburg/ Westminster	Nashua	U	14	1981	423237/715052
Scarborough Golf Course Pond†	7	Boston	Charles	U	11	1986	-
Scargo Pond	53	Dennis	Cape Cod	S	5	1982	414450/701100
School Pond	-	Boston	Charles	U	11	1981	421730/711000
Schoolhouse Pond	21	Chatham	Cape Cod	S	2	1980	414140/695950
Seth's Pond	11	West Tisbury	Islands	U	3	1983	412600/703950

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Shaker Mill Pond	20	West Stockbridge	Housatonic	U	4	1978	422020/732210
Shallow Pond†	67	Barnstable	Cape Cod	U	8	1983	414040/701930
Shaw Pond†	100	Becket/Otis	Farmington	S	5	1986	421505/730725
Sheep Pond†	148	Brewster	Cape Cod	S	4	1986	414415/700405
Sherman Pond†	86	Brimfield	Quinebaug	S	8	1985	420806/721140
Sherman Reservoir	162	Monroe/Rowe/ Whitingham, VT	Deerfield	S	4	1988	424400/725540
Lake Shirley†	376	Lunenburg/Shirley	Nashua	S	11	1977	423320/714115
Shubael Pond	56	Barnstable	Cape Cod	S	6	1980	414020/702337
Sibley Pond (South Basin)†	19	Charlton	Quinebaug	S	12	1984	420900/720040
Silver Lake†	10	Agawam	Connecticut	S	13	1982	420352/723807
Silver Lake	70	Bellingham	Blackstone	U	7	1978	420345/712755
Silver Lake†	23	Grafton	Blackstone	U	10	1980	421137/713919
Silver Lake†	28	Wilmington	Ipswich	S	9	1984	423357/721116
Singing Dam Impoundment	-	Sutton	Blackstone	U	16	1985	420939/714645
Singletary Pond†	330	Millbury/Sutton	Blackstone	S	8	1985	420939/714645
Slaters Pond	107	Oxford	French	S	4	1976	420700/714922
Sluice Pond†	50	Lynn	North Shore	S	6	1986	422920/705800
Snake Pond	83	Sandwich	Cape Cod	U	3	1980	414100/703115
Snows Millpond†	35	Fitchburg/ Westminster	Nashua	U	6	1981	423338/715115
South Athol Pond†	76	Athol	Millers	U	8	1979	423215/721530

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
South End Pond†	30	Millis	Charles	U	9	1977	421145/712100
South Meadow Pond (East)		Clinton	Nashua	S	9	1977	422455/714248
South Meadow Pond (West)	68	Clinton/Lancaster	Nashua	U	9	1977	422453/714225
South Spectacle Pond†	37	New Salem	Millers	S	11	1979	423052/721607
South Watuppa Pond†	1283	Fall River/ Westport	Mount Hope Bay	U	9	1989	413937/710745
Spectacle Pond†	16	Wilbraham	Chicopee	S	10	1986	420857/722515
Spectacle Pond	58	Lancaster	Nashua	S	8	1987	423042/714100
Spectacle Pond†	70	Littleton/Ayer	Nashua	S	10	1987	423042/714100
Sportsmans Pond†	102	Athol	Millers	U	10	1979	423632/721352
Spring Pond†	9	Saugus	North Shore	U	11	1985	422848/710307
Spy Pond†	103	Arlington	Mystic	S	11	1988	422430/710919
Stearns Mill Pond	19	Sudbury	Concord	U	14	1986	422309/712715
Stetson Pond†	93	Pembroke	Taunton	S	7	1985	420145/704940
Stiles Pond	60	Boxford	Ipswich	S	8	1978	424120/710215
Stiles Reservoir	346	Leicester/Spencer	French	S	9	1983	421242/715655
Stockbridge Bowl	374	Stockbridge	Housatonic	S	9	1976	422000/731900
Stoneville Reservoir	61	Auburn	Blackstone	U	5	1980	421230/715136
Straits Pond	91	Cohasset/Hull	Weymouth & Weir	U	9	1979	421554/705015
Sugden Reservoir***†	83	Spencer	Chicopee	S	11	1987	421615/715807
Sunset Lake†	300	Ashburnham/ Winchendon	Millers	S	12	1979	424100/715830

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Sunset Lake	5	Oak Bluffs	Islands	U	9	1976	412720/703348
Sunset Lake†	57	Braintree	Weymouth & Weir	S	10	1989	421209/710045
Sweet's Pond†	18	Mansfield	Taunton	U	6	1986	-
Taft Pond†	12	Upton	Blackstone	U	7	1989	420819/713548
Lake Tashmoo†*	259	Tisbury	Islands	U	-	1986	412730/703730
Ten Mile Reservation	-	Pawtucket, RI	Ten Mile	U	15	1984	-
Terry Brook Pond	10	Freetown	Taunton	S	10	1983	414640/710455
Texas Pond†	27	Oxford	French	U	11	1987	421017/715338
Thayer Pond†	9	Oxford	French	U	11	1987	420930/715305
Thirtyacre Pond	30	Brockton	Taunton	U	4	1975	420543/710245
Thompson Lake†	32	Palmer	Chicopee	U	5	1877	421030/721758
Thompsons Pond†	117	Spencer	Chicopee	S	7	1984	421810/715825
Tihonet Pond†	89	East Wareham	Buzzards Bay	S	11	1989	414730/704300
Tinkham Pond†	20	Acushnet/ Mattapoisett	Buzzards Bay	U	14	1980	414100/705130
Tisbury Great Pond†*	772	West Tisbury	Islands	U	-	1986	412100/703900
Todd Pond†	5	Lincoln	Charles	S	14	1985	422442/711907
Tripp Pond†	6	Hudson	Concord	U	8	1982	422323/713437
Tully Pond†	32	Orange	Millers	S	7	1979	423815/721430
Turner Pond†	55	Dartmouth/ New Bedford	Buzzards Bay	U	12	1980	414055/705836
Turner Reservoir	124	E. Providence, RI	Ten Mile	U	11	1984	-

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Turnpike Lake†	114	Plainville	Taunton	U	6	1979	420100/711620
Uncas Pond†	18	Franklin	Charles	S	9	1985	420345/712243
Upper Pond†	11	South Hadley	Connecticut	S	8	1984	421530/723420
Upper Goose Pond	45	Lee/Tyringham	Housatonic	S	4	1976	421712/731035
Upper Highland Lake	53	Goshen	Connecticut	U	4	1985	422737/724755
Upper Mill Pond†	253	Brewster	Cape Cod	U	11	1987	414345/700700
Upper Mystic Lake†	167	Winchester/ Arlington/Medford	Mystic	S	15	1978	422615/710900
Uptons Pond†	7	Tyngsborough	Merrimack	S	11	1979	424015/712525
Van Horn Pond†	9	Springfield	Chicopee	S	13	1978	420730/723550
Venture Pond†	7	Springfield	Connecticut	S	15	1987	420653/723024
Village Pond†	6	Truro	Cape Cod	U	11	1987	420158/700525
Lake Waban	108	Wellesley	Charles	S	9	1978	421719/711834
Waite Pond	54	Leicester	Blackstone	U	5	1977	421500/715330
Wakeby Pond†	351	Mashpee/Sandwich	Cape Cod	S	7	1986	414030/702910
Walden Pond†	58	Concord	Concord	S	4	1985	422620/712025
Waldo Lake†	70	Avon/Brockton	Taunton	U	8	1989	420634/710253
Walker Pond†	94	Sturbridge	Quinebaug	U	5	1976	420819/720339
Walker Pond†	7	Millis	Charles	U	9	1978	422220/711242
Walkers Pond†	105	Brewster	Cape Cod	U	10	1987	414320/700307
Wallum Lake	322	Douglas/ Burrillville, RI	Blackstone	S	2	1977	420006/714608

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Wampatuck Pond†	64	Hanson	South Shore	U	10	1980	420339/705203
Ward Pond†	51	Ashburnham	Millers	S	13	1979	424050/715300
Ware Impoundment	-	Ware	Chicopee	S	11	1980	421549/721344
Warners Pond	54	Concord	Concord	S	10	1974	422750/712409
Lake Warner (North Hadley Pond)†	68	Hadley	Connecticut	U	12	1979	422322/723430
Lake Watatic†	126	Ashburnham/Ashby	Millers	U	11	1979	424115/715615
Watershops Pond†	157	Springfield	Connecticut	S	10	1978	420615/723300
Watson Pond†	94	Taunton	Taunton	U	14	1989	415700/710710
Wattles Pond	10	Groton	Nashua	S	10	1979	423910/713405
Waushakum Pond†	81	Ashland/Framingham	Concord	S	8	1984	421545/712545
Webster Lake†	1181	Webster	French	S	6	1979	420230/715045
Wedge Pond†	21	Winchester	Mystic	S	13	1985	422717/710828
Weld Pond†	27	Dedham	Charles	U	7	1986	421500/711210
Wequaquet Lake†	654	Barnstable	Cape Cod	U	5	1980	414015/722030
Western Mass. Electric Impoundment	-	Ludlow/Wilbraham	Chicopee	S	8	1980	420915/722850
West Pond†	19	Bolton	Concord	S	8	1979	422540/713450
West Pond†	7	Gloucester	North Shore	U	11	1986	423450/704235
West Thompson Lake	200	Thompson, CT	Quinebaug	U	13	1989	-
West Waushakum Pond	112	Sterling	Nashua	S	7	1977	422455/714553
Wetherells Pond†	13	Plainville	Ten Mile	U	14	1984	420000/712015

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Lake Whalom	99	Leominster/ Lunenburg	Nashua	S	6	1977	423427/714530
Wheelers Pond†	22	Warwick	Millers	U	7	1979	423720/721935
Whitehall Pond	-	Rutland	Chicopee	S	5	1984	-
Whitehall Reservoir†	575	Hopkinton	Concord	S	9	1983	421345/713430
White Pond†	67	Athol	Millers	S	10	1979	423300/721530
White Pond	43	Concord	Concord	S	5	1979	422545/712330
White Pond†	48	Lancaster/ Leominster	Nashua	U	7	1979	423043/714300
White Island Pond†	294	Plymouth/Wareham	Buzzards Bay	S	13	1985	-
Whitmans Pond	210	Weymouth	Weymouth & Weir	S	10	1981	421215/705615
Whitney Pond†	107	Winchendon	Millers	S	10	1979	424050/720200
Wickaboag Pond†	320	West Brookfield	Chicopee	U	11	1988	421430/720915
Lake Wildwood†	38	Upton	Blackstone	S	10	1989	-
Willow Lake†	4	Northampton	Connecticut	U	6	1982	422052/724130
Willow Pond	1	Brookline	Charles	U	7	1978	421957/710650
Windsor Pond†	44	Windsor	Westfield	S	8	1989	422915/730626
Winnecunnet Pond	148	Norton	Taunton	U	8	1980	415815/710752
Winnekeag Lake†	118	Ashburnham	Nashua	S	10	1980	423940/715400
Winning Pond†	23	Billerica	Concord	S	10	1987	423305/711810
Winter Pond†	17	Winchester	Mystic	U	12	1985	422727/710912
Lake Winthrop†	150	Holliston	Charles	S	9	1979	421118/712520

CLASSIFIED LAKES AND PONDS (CONTINUED)

LAKE/POND	AREA (Acres)	LOCATION	DRAINAGE BASIN	STRATI-FICATION	SEVERITY POINTS	MOST RECENT DATE SURVEYED	LATITUDE/ LONGITUDE
Woods Pond†	122	Lenox/Lee	Housatonic	U	17	1981	422115/731420
Woods Pond†	52	Middleborough	Taunton	U	6	1985	-
Wrights Reservoir†	128	Gardner/ Westminster	Millers	U	7	1987	423245/715815
Wyman Pond†	200	Westminster	Nashua	S	12	1981	423134/715236
Lake Wyola†	129	Shutesbury	Connecticut	S	7	1988	423000/722545
Yokum Pond	109	Becket	Westfield	U	3	1978	421815/730730

* = Salt water
** = Insufficient data
*** = Sampled after dam breached. Under normal conditions, severity points may drop.
- = No data available
S = Stratified
U = Stratified
D/F = Diagnostic/Feasibility Study
† = Partially or entirely impaired or threatened

LISTING OF HIGH ACIDITY LAKES AND PONDS

TABLE 1. List of ponds on Palis[1] database with an in-lake surface pH of 4.5 or less measured on at least one sampling occasion.

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
95173	White Island Pond	Plymouth	06/14/77	***	2.9
35072	Ruggles Pond	Wendell	07/11/84	1.0	4.1
62030	Cain Pond	Taunton	06/22/87	3.0	4.1
62114	Memorial Park Pond	Taunton	06/22/83	***	4.1
96179	Long Pond	Wellfleet	07/28/80	***	4.1
36025	Browning Pond	Oakham/Spencer	08/19/87	1.0	4.4
94176	Gallows Pond	Plymouth	06/26/84	2.0	4.4
96035	Clapps Pond	Provincetown	07/28/80	***	4.4
34005	Arcadia Lake	Belchertown	08/31/78	0.0	4.5
95092	Little Sandy Pond	Plymouth	07/29/87	3.0	4.5
96101	Fresh Pond	Dennis	07/31/80	0.0	4.5
97096	Tom Nevers Pond	Nantucket	09/20/78	0.0	4.5

*** Missing data
[1] Ponds and Lakes Information System

TABLE 2. List of ponds on PALIS database with an in-lake surface total alkalinity value of 2.0 mg/l or less measured on at least one occasion.

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
34005	Arcadia Lake	Belchertown	08/31/78	0.0	4.5
96101	Fresh Pond	Dennis	07/31/80	0.0	4.5
97096	Tom Nevers Pond	Nantucket	09/20/78	0.0	4.5
95148	Tinkham Pond	Mattapoisett	08/28/80	0.0	4.7
97053	Maxcy Pond	Nantucket	09/18/78	0.5	4.6
35072	Ruggles Pond	Wendell	07/11/84	1.0	4.1
36025	Browning Pond	Oakham/Spencer	08/19/87	1.0	4.4
95151	Turner Pond	New Bedford	06/25/80	1.0	4.6
96090	Flax Pond	Dennis	07/31/80	1.0	4.8
35057	Partridgeville Pond	Templeton	09/11/79	1.0	4.9
97028	Gibbs Pond	Nantucket	09/20/78	1.0	5.2
81035	East Waushacum Pond	Sterling	08/20/80	1.0	6.2
94096	Maquan Pond	Hanson	08/31/82	1.0	6.2
96285	Shallow Pond	Barnstable	08/03/83	1.5	4.8
94176	Gallows Pond	Plymouth	06/26/84	2.0	4.4
35086	Sunset Lake	Ashburnham	08/27/79	2.0	5.1
35095	Watatic Pond	Ashburnham	08/28/79	2.0	5.1
35104	Wright's Reservoir	Gardner/ Westminster	09/14/87	2.0	4.9
95123	Round Pond	Plymouth	06/28/84	2.0	5.5
81161	Wyman Pond	Westminster	10/15/80	2.0	5.7
74007	Cranberry Pond	Braintree	08/31/81	2.0	5.8
62131	Lake Nippenicket	Bridgewater	07/23/75	2.0	5.8
35041	Lower Naukeag Lake	Ashburnham	08/27/79	2.0	5.8
36132	Queen Lake	Phillipston	05/20/79	2.0	5.9
95166	White Island Pond (East)	Plymouth	07/28/77	2.0	6.1
96140	Hinckleys Pond	Harwich	07/30/80	2.0	6.4
81127	Snows Millpond	Fitchburg	09/01/81	2.0	7.3
72039	Farm Pond	Sherborn	07/21/83	2.0	***

*** Missing data

TABLE 3. List of ponds on PALIS database with an in-lake total alkalinity value greater than 2.0 mg/l and less than 6.0 mg/l measured on at least one occasion.

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
62030	Cain Pond	Taunton	06/22/87	3.0	4.1
95092	Little Sandy Pond	Plymouth	07/29/87	3.0	4.5
81157	Winnekeag Lake	Ashburnham	09/29/80	3.0	4.7
34035	Lake Holland	Belchertown	08/31/78	3.0	5.1
95051	Ezekiel Pond	Plymouth	07/29/87	3.0	5.2
81073	Long Pond	Ayer	07/16/84	3.0	5.3
62187	Terry Brook Pond	Freetown	08/30/83	3.0	5.5
94097	Mare Pond	Plymouth	07/13/82	3.0	5.8
97085	Seths Pond	West Tisbury	12/14/76	3.0	5.9
35035	Laurel Lake	Erving	09/18/79	3.0	6.0
62162	Robbins Pond	East Bridgewater	07/24/75	3.0	6.0
33018	Sherman Reservoir	Monroe/Rowe	07/19/88	3.0	6.1
96123	Gull Pond	Wellfleet	07/28/80	3.0	6.1
96061	Depot Pond	Eastham	07/29/80	3.0	6.2
96253	Queen Sewell Pond	Bourne	08/14/80	3.0	6.2
36053	Dimmock Pond	Springfield	07/11/78	3.0	6.4
96329	Village Pond	Truro	07/28/80	3.0	6.5
95173	White Island Pond (West)	Plymouth	08/11/76	3.0	6.5
62103	Leach Pond	Easton	06/05/84	4.0	4.7
35015	Davenport Pond	Petersham	08/11/82	4.0	4.8
35047	Lake Monomonac	Winchendon	03/09/76	4.0	4.9
94015	Bloody Pond	Plymouth	06/26/84	4.0	5.4
35017	Lake Denison	Winchendon	07/11/84	4.0	5.7
36012	Bemis Road Pond	Hubbardston	07/02/79	4.0	5.9
35094	Ward Pond	Ashburnham	08/28/79	4.0	5.9
35048	Moores Pond	Warwick	07/01/87	4.0	6.1
95112	New Long Pond	Plymouth	06/28/84	4.0	6.1
36172	Camp Putnam Pond	New Braintree	06/09/76	4.0	6.2

TABLE 3. CONTINUED

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
81084	Mirror Lake	Fitchburg	07/26/79	4.0	6.2
42047	Robinson Pond	Oxford	06/21/76	4.0	6.2
35081	South Spectacle Pond	New Salem	08/30/79	4.0	6.2
96333	Wequaquet Lake	Barnstable	08/11/80	4.0	6.2
35053	Packard Pond	Orange	09/20/79	4.0	6.3
96293	Shubael Pond	Barnstable	08/12/80	4.0	6.3
96008	Baker Pond	Orleans	07/30/80	4.0	6.4
96289	Sheep Pond	Brewster	08/30/80	4.0	6.5
35101	Whitney Pond	Winchendon	06/17/87	4.0	6.6
81051	Greenes Pond	Fitchburg	07/18/79	4.0	6.6
32061	Russell Pond	Russell	06/22/78	4.0	6.6
35082	Sportsmans Pond	Athol	08/09/79	4.0	6.6
96087	Flax Pond	Bourne	08/14/80	4.0	6.7
82118	White Pond	Concord	06/07/79	4.0	6.7
72140	Lake Winthrop	Holliston	07/24/79	4.0	6.8
96194	Mashpee & Wakeby Ponds	Mashpee	08/12/80	4.0	6.8
35070	Lake Rohunta	Athol	08/04/81	4.0	6.9
34103	Lake Wyola	Shutesbury	07/13/78	4.0	7.0
93056	Pillings Pond	Lynnfield	04/28/77	5.0	5.5
95113	Noquochoke Lake (Middle)	Dartmouth	08/06/79	5.0	5.7
42064	Webster Lake	Webster	07/01/76	5.0	5.8
81054	Harbor Pond	Townsend	06/07/84	5.0	5.9
97019	Duarte Pond	Oak Bluffs	02/17/76	5.0	6.0
36084	Lake Lorraine	Springfield	08/07/78	5.0	6.0
82124	Nutting Lake (West Basin)	Billerica	01/29/86	5.0	6.3
81034	Eagle Lake	Holden	04/23/79	5.0	6.3
42018	Gore Pond	Dudley	06/23/76	5.0	6.3
42053	Slaters Pond	Oxford	06/22/76	5.0	6.3

TABLE 3. CONTINUED

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
82120	Whitehall Reservoir	Hopkinton	08/25/83	5.0	6.3
42024	Hayden Pond	Dudley	06/30/87	5.0	6.5
81082	McTaggarts Pond	Fitchburg	07/19/79	5.0	6.5
81098	Partridge Pond	Westminster	08/29/79	5.0	6.5
36150	Sugden Reservoir	Spencer	04/23/80	5.0	6.5
95093	Little West Pond	Plymouth	08/05/87	5.0	6.5
94114	Oldham Pond	Pembroke	07/16/80	5.0	6.6
96012	Bearse Pond	Barnstable	08/03/83	5.0	6.7
96039	Cliff Pond	Brewster	07/29/80	5.0	6.7
35023	Ellis Pond	Athol	08/08/79	5.0	6.7
97054	Menemsha Pond	Gay Head	12/14/76	5.0	6.7
42042	Peter Pond	Dudley	08/06/87	5.0	6.8
36092	Lake Mattawa	Orange	06/18/75	5.0	6.8
96279	Scargo Lake	Dennis	08/24/82	5.0	6.8
72035	Echo Lake	Milford	07/25/78	5.0	7.3
36052	Diamond International Impoundment	Palmer	08/19/80	5.0	7.5
34073	Porter Lake	Springfield	08/15/79	5.0	7.5
35034	Kendall Pond	Gardner	09/11/79	5.5	5.9

TABLE 4. List of ponds on PALIS database with an in-lake total alkalinity value equal to or greater than 6.0 mg/l and less than or equal to 10.0 mg/l measured on at least one occasion.

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
96184	Long Pond	Barnstable	08/15/83	6.0	5.2
36082	Long Pond	Rutland	06/13/84	6.0	5.4
34096	Venture Pond	Springfield	08/11/87	6.0	5.6
95096	Long Pond	Plymouth	08/01/84	6.0	5.6
36173	White Pond	Rutland	06/13/84	6.0	5.6
95171	Noquochoke Lake (North)	Dartmouth	08/06/79	6.0	5.7
42055	Stiles Reservoir	Spencer	07/05/83	6.0	5.7
36061	Five Mile Pond	Springfield	08/07/78	6.0	6.2
35097	Wheelers Pond	Warwick	09/18/79	6.0	6.3
35052	North Spectacle Pond	New Salem	08/30/79	6.0	6.4
72030	Silver Lake	Newton	02/05/80	6.0	6.4
35078	South Athol Lake	Athol	08/07/79	6.0	6.4
96050	Crystal Lake	Orleans	08/02/82	6.0	6.5
96157	Johns Pond	Mashpee	08/13/80	6.0	6.5
82071	Little Pond	Bolton	06/12/79	6.0	6.5
34051	Metacomet Lake	Belchertown	08/31/78	6.0	6.5
82061	Hopkinton Reservoir	Ashland/ Hopkinton	06/22/88	6.0	6.6
41008	Cedar Pond	Sturbridge	04/17/80	6.0	6.6
42067	Clara Barton Pond	Oxford	08/30/82	6.0	6.6
96146	Hoxie Pond	Sandwich	08/12/80	6.0	6.6
42043	Pierpoint Meadow Pond	Dudley	08/31/83	6.0	6.6
31008	Cranberry Pond	Tolland	08/01/79	6.0	6.7
96106	Goose Pond	Chatham	07/30/80	6.0	6.7
35048	Moores Pond	Warwick	09/24/79	6.0	6.7
31004	Big Pond	Otis	07/30/79	6.0	6.8
35021	Dunn Pond	Gardner	09/13/79	6.0	6.8

TABLE 4. CONTINUED

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
31027	Otis Reservoir	Otis	07/31/79	6.0	6.8
35098	White Pond	Athol	08/07/79	6.0	6.8
32076	Windsor Pond	Windsor	08/09/78	6.0	6.8
94057	Halfway Pond	Plymouth	06/26/84	7.0	5.3
32040	Hammond Pond	Goshen	08/10/78	7.0	6.2
95088	Little Long Pond	Plymouth	06/27/84	7.0	6.3
36130	Quaboag Pond	Brookfield	02/10/75	7.0	6.3
92038	Martins Pond	North Reading	04/21/87	7.0	6.4
84053	Peters Pond	Dracut	06/28/79	7.0	6.5
81107	Putnam Pond	Fitchburg	07/19/79	7.0	6.5
62001	Ames Long Pond	Taunton	08/17/87	7.0	6.5
95170	Noquochoke Lake (South)	Dartmouth	08/06/79	7.0	6.7
81017	Chaffin Pond	Holden	06/28/77	7.0	6.8
36131	Quacumquasit Pond	Brookfield	10/21/74	7.0	6.8
51009	Bell Pond	Worcester	06/05/79	7.0	6.9
42049	Sargent Pond	Leicester	07/09/87	7.0	7.0
92063	Stiles Pond	Boxford	09/14/78	7.0	7.0
72126	Walker Pond	Waltham	07/20/78	7.0	7.4
35007	Bents Pond	Gardner	09/19/79	7.5	6.3
31027	Otis Reservoir	Otis	08/16/88	8.0	5.3
62218	Monponsett Pond (East)	Halifax	08/03/82	8.0	5.4
36155	Thompsons Pond	Spencer	06/12/84	8.0	5.5
74025	Whitmans Pond	Weymouth	03/16/81	8.0	6.3
36171	Red Bridge Impoundment	Ludlow	04/25/77	8.0	6.5
36023	Brooks Pond	North Brookfield	08/10/83	8.0	6.6
62166	Lake Sabbatia	Taunton	08/25/80	8.0	6.6
51091	Manchaug Pond	Douglas	06/06/77	8.0	6.6

TABLE 4. CONTINUED

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
62119	Monponsett Pond (West)	Halifax	08/03/82	8.0	6.7
32054	Norwich Pond	Huntington	08/09/78	8.0	6.7
84017	Frye Pond	Haverhill	07/28/83	8.0	6.8
36162	Ware Impoundment	Ware	07/15/80	8.0	6.8
36115	Graves Brook Reservoir	Palmer	07/12/84	8.0	6.9
41046	Sherman Pond	Brimfield	07/01/76	8.0	6.9
36020	Brigham Pond	Hubbardston	07/02/79	8.0	7.0
51152	Singletary Pond	Sutton	08/31/77	8.0	7.0
93014	Chebacco Lake	Hamilton	06/29/81	8.0	7.1
82011	Boons Pond	Stow	07/17/79	8.0	7.5
84002	Lake Attitash	Amesbury	03/09/78	9.0	5.8
51109	Mumford River Impoundment	Douglas	08/16/84	9.0	5.9
82003	Ashland Reservoir	Ashland	07/02/81	9.0	6.0
36066	Hardwick Pond	Hardwick	08/04/81	9.0	6.0
36079	Lake Lashaway	North Brookfield	10/22/80	9.0	6.2
96324	Upper Mill Pond	Brewster	09/01/87	9.0	6.4
31026	Noyes Pond	Tolland	07/30/79	9.0	6.4
81007	Bare Hill Pond	Harvard	08/03/78	9.0	6.6
36040	Cranberry Meadow Pond	Charlton	06/04/84	9.0	6.6
62198	Turnpike Lake	Plainville	06/27/79	9.0	6.6
96188	Lower Mill Pond	Brewster	09/01/81	9.0	6.7
51010	Brierly Pond	Millbury	06/05/79	9.0	6.7
36032	Chicopee Falls Impoundment	Chicopee	08/26/80	9.0	6.8
35089	Tully Pond	Orange	09/20/79	9.0	6.9
62213	Winnecunnet Pond	Norton	06/05/80	9.0	6.9

TABLE 4. CONTINUED

PALIS NUMBER	NAME OF LAKE	TOWN	DATE SURVEYED	ALKALINITY (mg/l)	pH (Standard Units)
32060	Rudd Pond	Becket	06/21/78	9.0	7.0
81132	Spectacle Pond	Lancaster	09/10/87	9.0	7.2
96004	Ashumet Pond	Mashpee	08/13/80	9.0	7.2
32079	Yokum Pond	Becket	06/21/78	9.0	7.2
21029	East Indies Pond	New Marlborough	08/23/78	9.0	7.3
34047	Lower Highland Lake	Goshen	07/12/78	9.0	7.3
36056	Eames Pond	Paxton	06/12/84	10.0	5.5
36093	Minechoag Pond	Ludlow	09/14/87	10.0	5.8
36073	Howe Pond	Spencer	06/14/84	10.0	6.0
82088	Nutting Lake (East)	Billerica	12/19/83	10.0	6.3
84012	Flint Pond	Tyngsborough	04/11/77	10.0	6.6
62166	Lake Sabbatia	Taunton	08/10/88	10.0	6.6
36094	Mona Lake	Springfield	08/08/78	10.0	6.7
36083	Long Pond	Springfield	08/08/78	10.0	6.8
42058	Texas Pond	Oxford	07/29/74	10.0	6.8
35008	Bourn-Hadley Pond	Templeton	09/24/79	10.0	6.9
84033	Long Sought-for Pond	Westford	06/25/74	10.0	6.9
36166	Wickaboag Pond	West Brookfield	07/16/74	10.0	6.9
42019	Granite Reservoir	Charlton	07/30/74	10.0	7.1
95129	Sassaquin Pond	New Bedford	06/12/80	10.0	7.1
61006	South Watuppa Pond	Fall River	10/24/74	10.0	7.1
81164	Bower Springs Pond (East)	Bolton	08/21/79	10.0	7.2
36083	Long Pond	Springfield	08/05/87	10.0	9.3
21005	Ashmere Lake	Hinsdale	08/16/83	10.0	***

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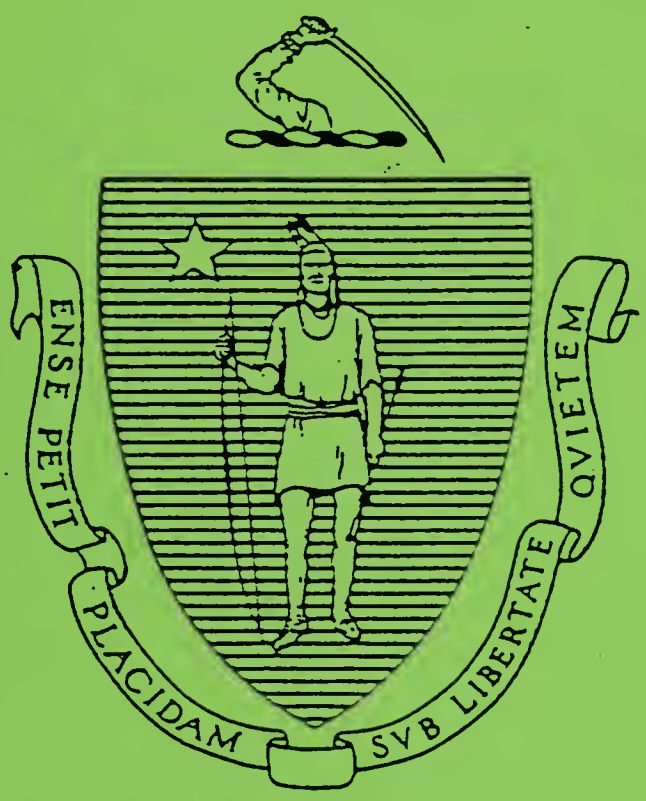
COMMONWEALTH OF MASSACHUSETTS SUMMARY OF WATER QUALITY

1990



Executive Summary

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner

DIVISION of WATER POLLUTION CONTROL

Arleen O'Donnell, Acting Director

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COMMONWEALTH OF MASSACHUSETTS

SUMMARY OF WATER QUALITY

1990

EXECUTIVE SUMMARY

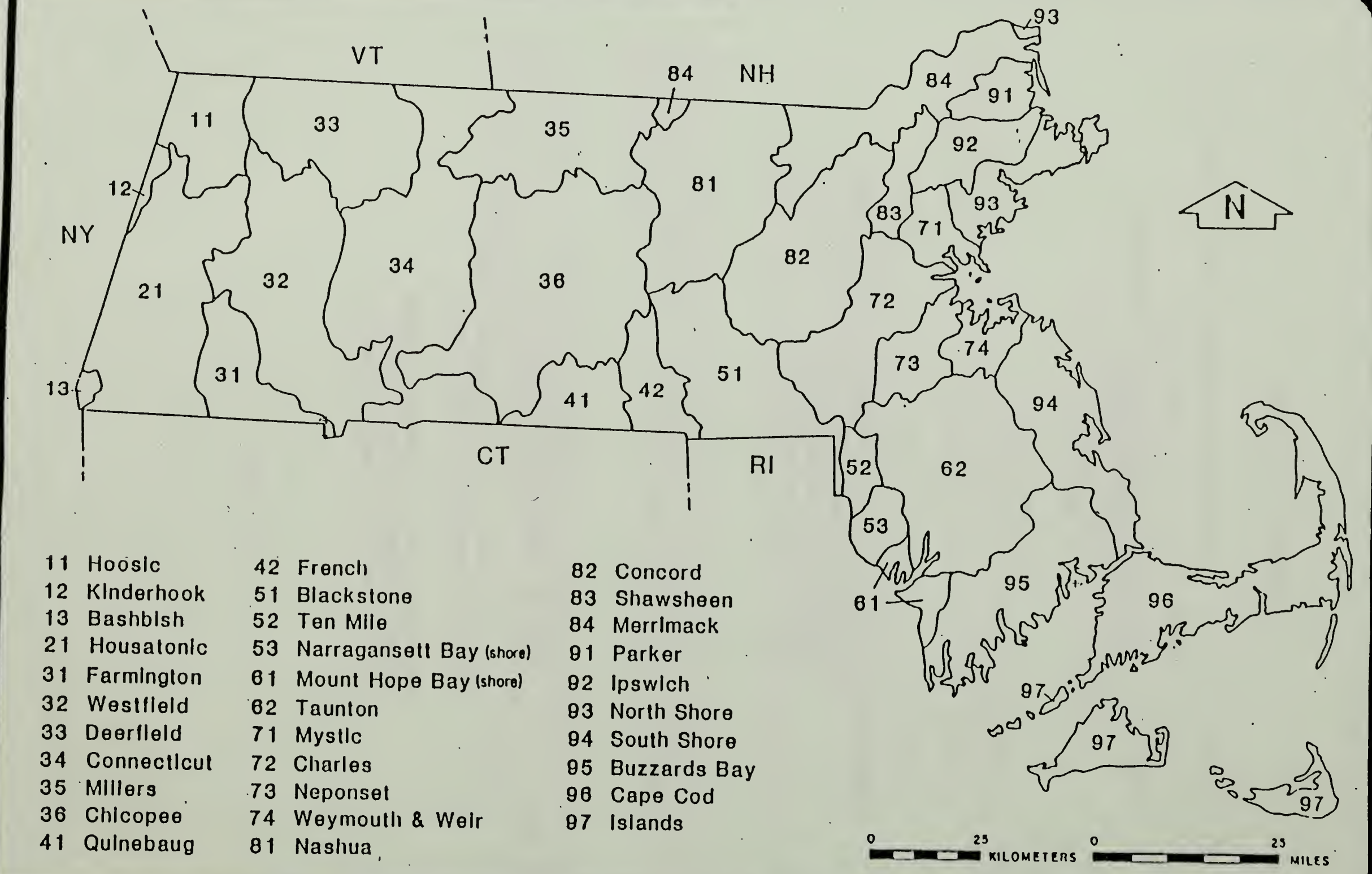
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER POLLUTION CONTROL
TECHNICAL SERVICES BRANCH
WESTBOROUGH, MASSACHUSETTS

Executive Office of Environmental Affairs
John P. DeVillars, Secretary

Massachusetts Department of Environmental Protection
Daniel S. Greenbaum, Commissioner

Division of Water Pollution Control
Arleen O'Donnell, Acting Director
Brian M. Donahoe, Deputy Director

May 1990



11	Hoosic	42	French	82	Concord
12	Kinderhook	51	Blackstone	83	Shawsheen
13	Bashbish	52	Ten Mile	84	Merrimack
21	Housatonic	53	Narragansett Bay (shore)	91	Parker
31	Farmington	61	Mount Hope Bay (shore)	92	Ipswich
32	Westfield	62	Taunton	93	North Shore
33	Deerfield	71	Mystic	94	South Shore
34	Connecticut	72	Charles	95	Buzzards Bay
35	Millers	73	Neponset	96	Cape Cod
36	Chicopee	74	Weymouth & Weir	97	Islands
41	Quinebaug	81	Nashua		

Figure **A**

COMMONWEALTH OF MASSACHUSETTS
RIVER BASINS and COASTAL DRAINAGE AREAS

1.0 EXECUTIVE SUMMARY

1.1 The 305(b) Process

The Federal Clean Water Act (CWA) establishes a process for the development of information concerning the quality of the Nation's waters and reporting this information to the Environmental Protection Agency (EPA) and the U.S. Congress. Each state must develop a program to monitor the quality of its surface and ground water and prepare a report every two years describing the status of water quality. This process, referred to as the 305(b) process, is the principal means by which the EPA, Congress, and the public evaluate water quality, the progress made in maintaining and restoring water quality, and the extent to which problems remain.

In 1988, EPA began the implementation of an automated data management to record the results of water quality assessments and manage newly-required assessment information under the Water Quality Act of 1987. The Section 305(b) Waterbody System (WBS) is under implementation in Massachusetts and attempts to improve consistency in guidance for determining use support, determining total state waters and assessing trends. The effort to implement these new guidelines makes this year's report incomparable with previous year's reports but provides a common basis for future assessment with other states.

Under the January 12, 1989 proposal to amend the Water Quality Management Regulation (40 CFR Part 130), the Section 305(b) reporting process will become the long-term vehicle for WQA reporting on lakes, nonpoint source pollution, and toxics in surface waters.

1.2 River Assessment

Approximately 80% of the over 8,000 river miles in the Commonwealth are unpolluted and are not included in this assessment. These waters consist mostly of small headwater streams. The assessed waters include only 20% of the river miles, but consist of all the principal main stem rivers and therefore the larger proportion of the stream flow.

Assessed rivers break down nearly evenly into thirds for support, partial support and nonsupport of designated uses (Figure 1.1A). This is comparable with the rivers support status ten years ago. However, the analysis shows that the pollution load to these rivers has been greatly reduced over the past ten years. Pollutants such biochemical oxygen demand and nutrients have been reduced by about one half. Ammonia and suspended solids have been virtually eliminated as causes of non attainment (Figure 1.1B). This improvement is largely due to the joint federal and state Construction Grants Program that has distributed over 2.5 billion dollars in sewage treatment grants to Massachusetts municipalities since 1967. One hundred thirty-nine (139) publicly owned treatment works (POTW's) are permitted under the National Pollutant Discharge Elimination System (NPDES) which collect and treat over one billion gallons of sanitary and industrial wastewater each day and serve over 70% of the state's population. Due to this effort municipal and industrial point sources have been significantly reduced as sources of non attainment (Figure 1.1C).

Over 65% of the rivers assessed now meet the fishable goal and 42% meet the swimmable goal (Figure 1.4A). The major benefit of pollution control efforts has been the increase in waters meeting the fishable goal. The swimming goal continues to not be met because of the overlapping effects of nonpoint source pollution. This also prevents most waters from meeting their designated uses, for nearly all surface waters in Massachusetts are designated for both fishing and swimming. The most prominent source of non attainment in rivers is urban runoff. The percentage of river miles adversely impacted remains the same as 1979 (approximately 40%). The cause of non attainment that is detected by the monitoring program is pathogen indicators (high bacterial counts). This parameter has not undergone the substantial reduction of other pollutants. Both the cause and the source may be over simplifications of the problem. "Urban runoff" may, on closer inspection, include broken and leaking sanitary sewers, small illicit discharges of waste, periodic dumps or spills or other similar activities. Increased monitoring may reveal metals, organics and oil and grease in sediments in addition to the pathogen indicators already detected. Nonpoint source management planning and stormwater permitting efforts have been intensified during the past year in order to better address these problems.

About 20% of the rivers assessed (4% of the total river miles in the state) exhibit high levels of toxic pollutants (Figure 1.5A). The pollutants consist mostly of metals and priority organics in the sediments and fish flesh (Figure 1.5B and C). Six major fishing advisories account for half of the problem. With few exceptions, the pollution appears to be from a history of prior pollution and not from active discharges of these pollutants. Abatement measures for in-place sediments need to be developed.

1.3 Lakes Assessment

Over 40% of the lake and pond acres in the state are assessed in this year's report, but 40% of these acres belong to one waterbody: Quabbin Reservoir. The inclusion of this waterbody heavily skewed the results of the entire assessment. Elevated levels of mercury in fish flesh has resulted in a fishing advisory on the reservoir and an assessment of nonsupport. This is responsible for all but 1.6% of the nonsupport acres in the assessment, and for all of the metals category in the causes of non attainment (Figure 1.2A and B). Over 70% of the lakes assessed meet the swimmable goal and, with the exception of Quabbin Reservoir, 96.6% of the acres assessed meet the fishable goal. Major causes of non attainment include nutrients and excessive aquatic plant growths. The major sources of these problems are unknown but believed to be various nonpoint sources.

1.4 Marine Water Assessment

Marine waters receive 75% of the total daily discharge of municipal wastewater in the Commonwealth (primarily in Boston Harbor). The cleanup of these sources has lagged behind the cleanup of rivers. The assessment shows that nearly 75% of the marine waters assessed do not support their designated uses. This is primarily due to municipal point sources and Combined Sewer Overflows (CSO's) contributing to the bacterial contamination of these waters (Figure 1.3C). However, nonpoint source pollution is perceived as a significant problem, although not fully assessed at this time. Information from unassessed waters indicates a disturbing downward trend in water quality in

marine waters. This is most likely due to the rapid development of shoreline areas during the eighties.

Although only 13.2% of the waters assessed supported their designated uses nearly 40% supported the swimmable goal and nearly 60% supported the fishable goal (Figure 1.4C). Since the marine monitoring program has concentrated on documenting contaminated areas, it can be assumed that more representative sampling would reveal even high percentages meeting the CWA goals.

1.5 Toxic Pollutant Assessment

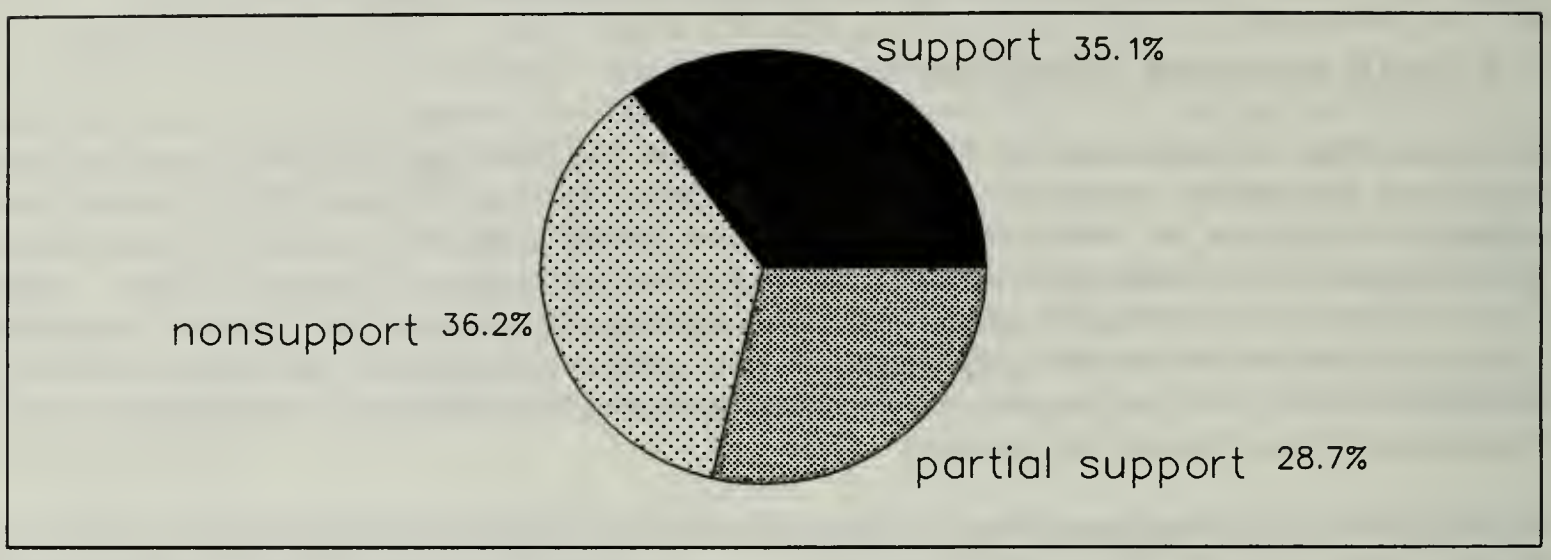
Although the assessment of toxic pollutants in the Commonwealth has progressed with new sampling techniques and analytical methods, it is by no means considered complete or comprehensive. The current analysis shows the highest percentage of contamination occurring in marine waters (Figure 1.5A). River waters show a lower percentage of contamination (20% of the waters assessed) than the other two waterbody types. The Lakes assessment is due entirely to contamination of fish flesh in Quabbin Reservoir. Other lakes remain unassessed for toxic pollution.

The causes of nonsupport are a mixture of metals, priority organics and other toxic pollutants. These contaminants are usually detected in the sediments or biota and not in the water column. Marine waters were the only waterbody type showing significant water column contamination. This was primarily due to ammonia in Boston Harbor. The state is making major revisions to its water quality standards in order to better address toxic pollutants.

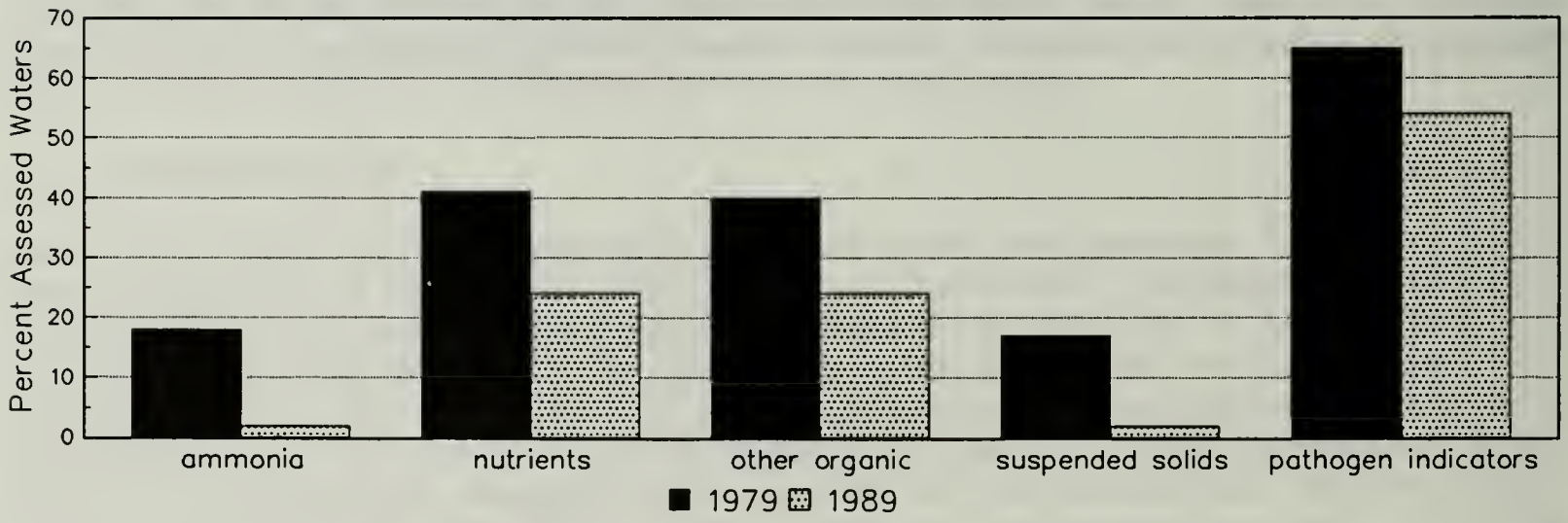
Figure 1.1

RIVER ASSESSMENT – 1989

A. Designated Use Support



B. Causes of Non Attainment



C. Sources of Non Attainment

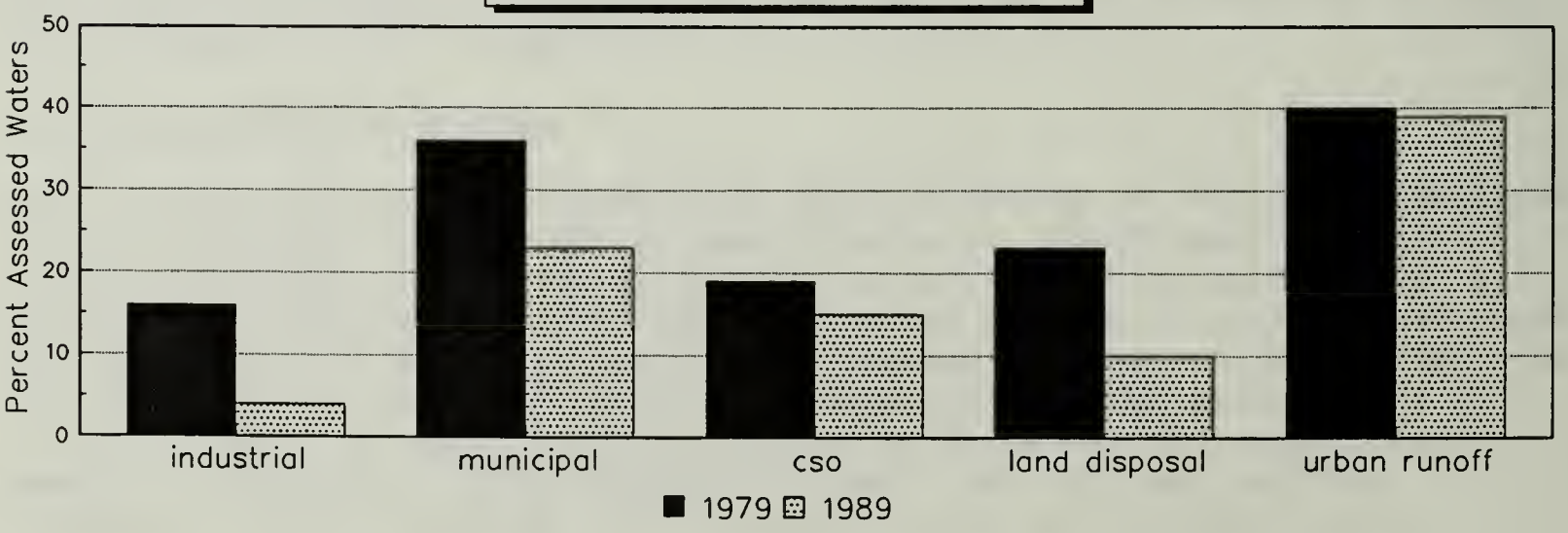
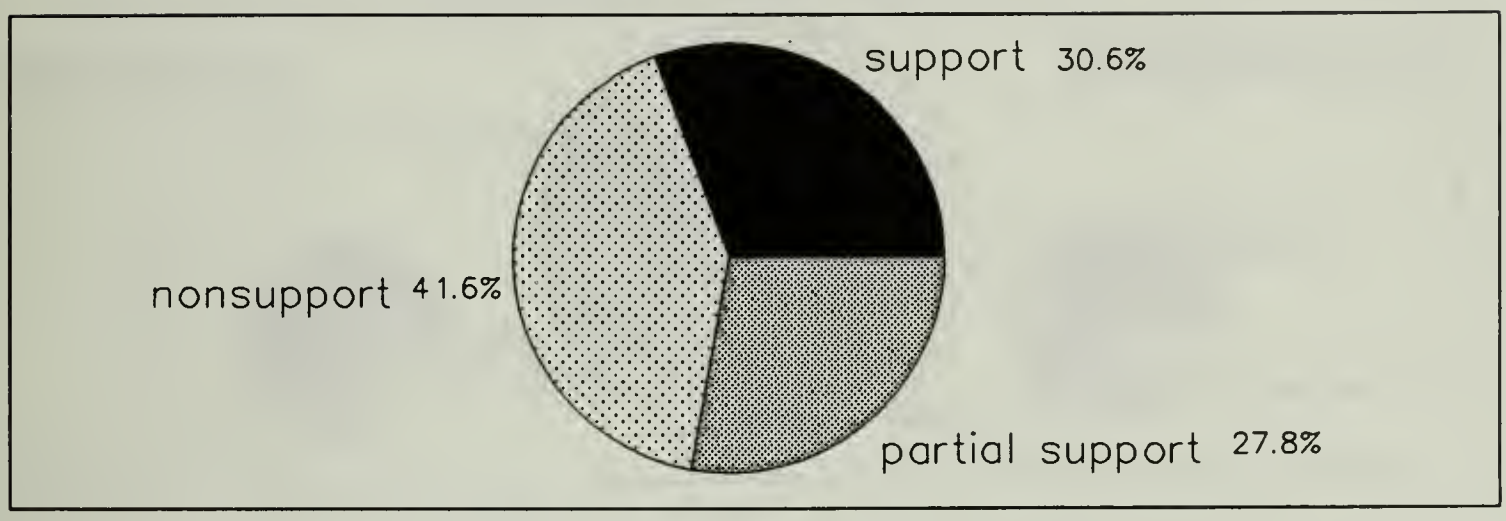


Figure 1.2

LAKES ASSESSMENT – 1989

A. Designated Use Support



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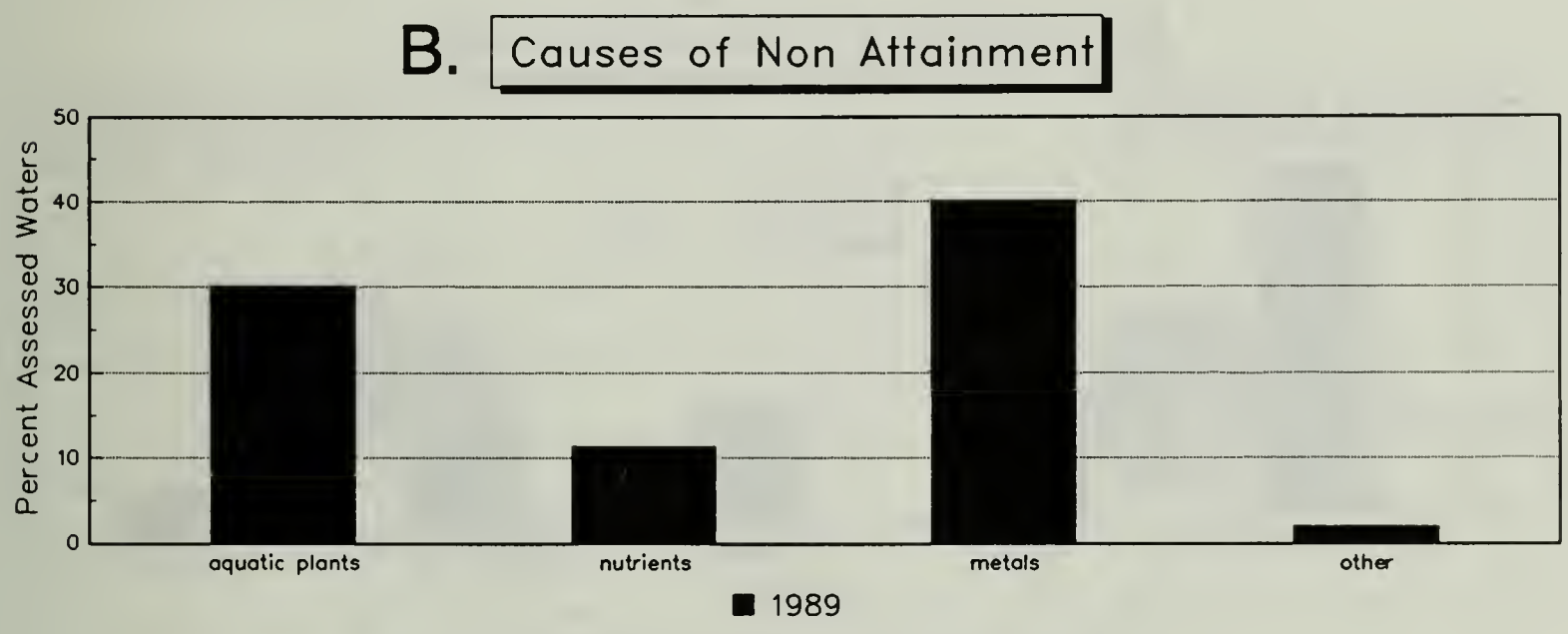


C. Sources of Non Attainment

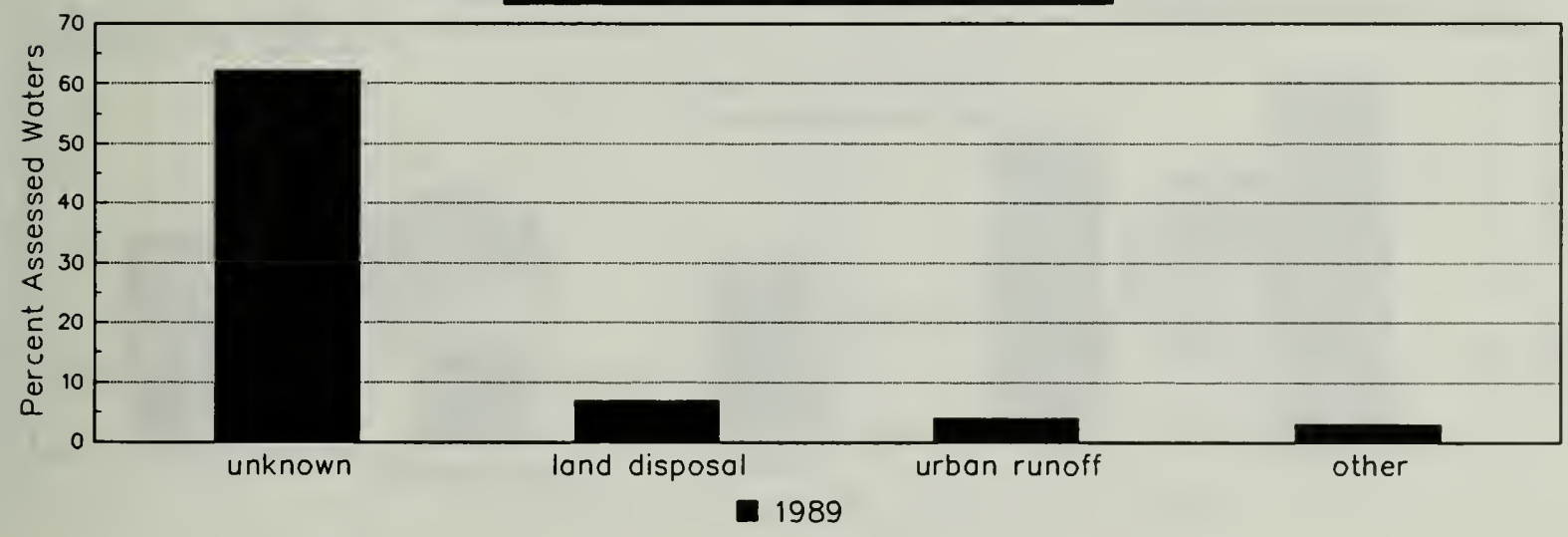
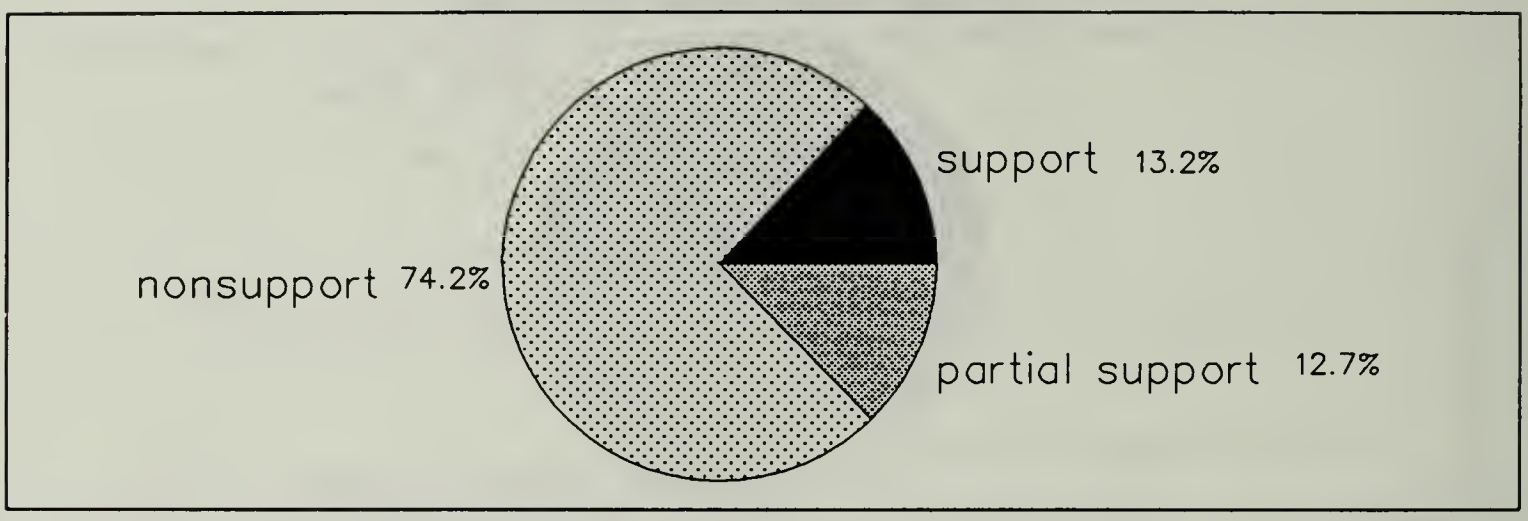


Figure 1.3

MARINE WATERS ASSESSMENT – 1989

A. Designated Use Support



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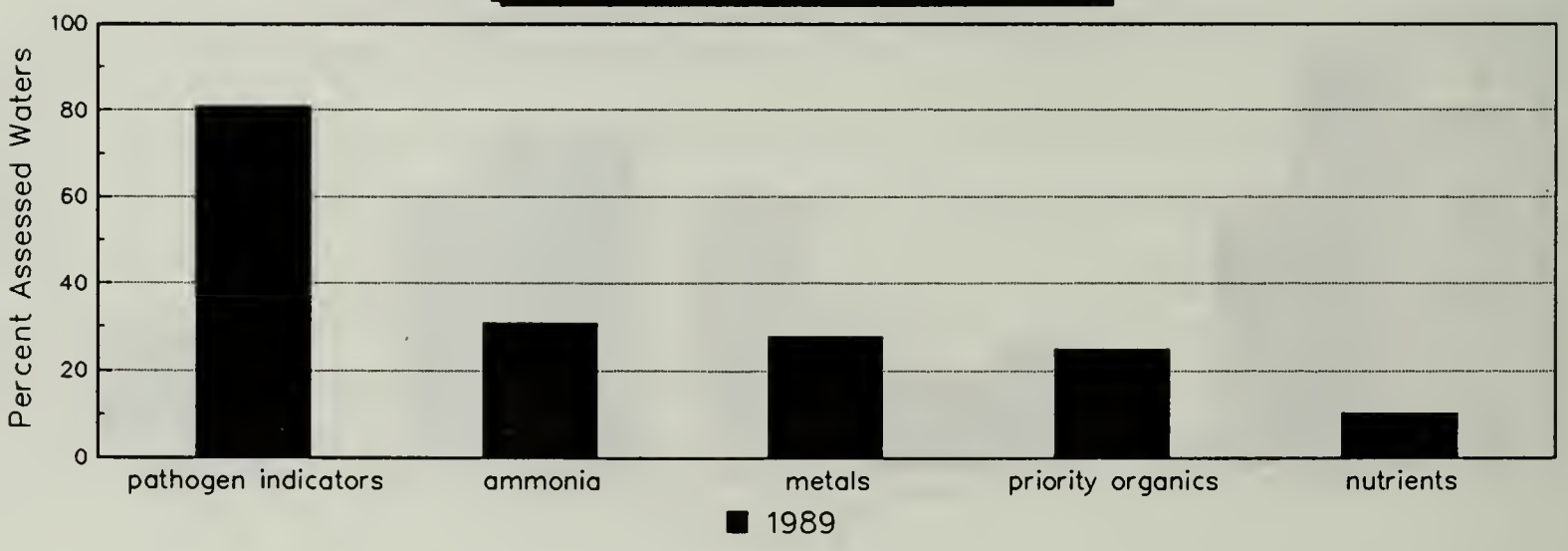

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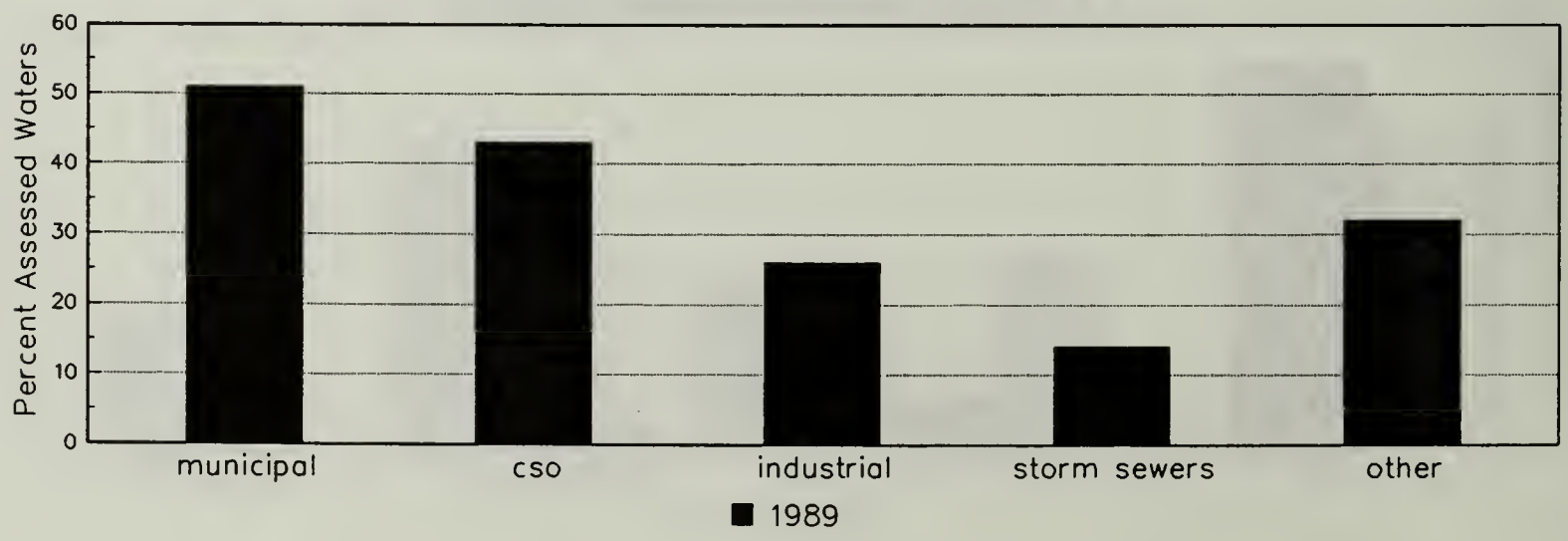
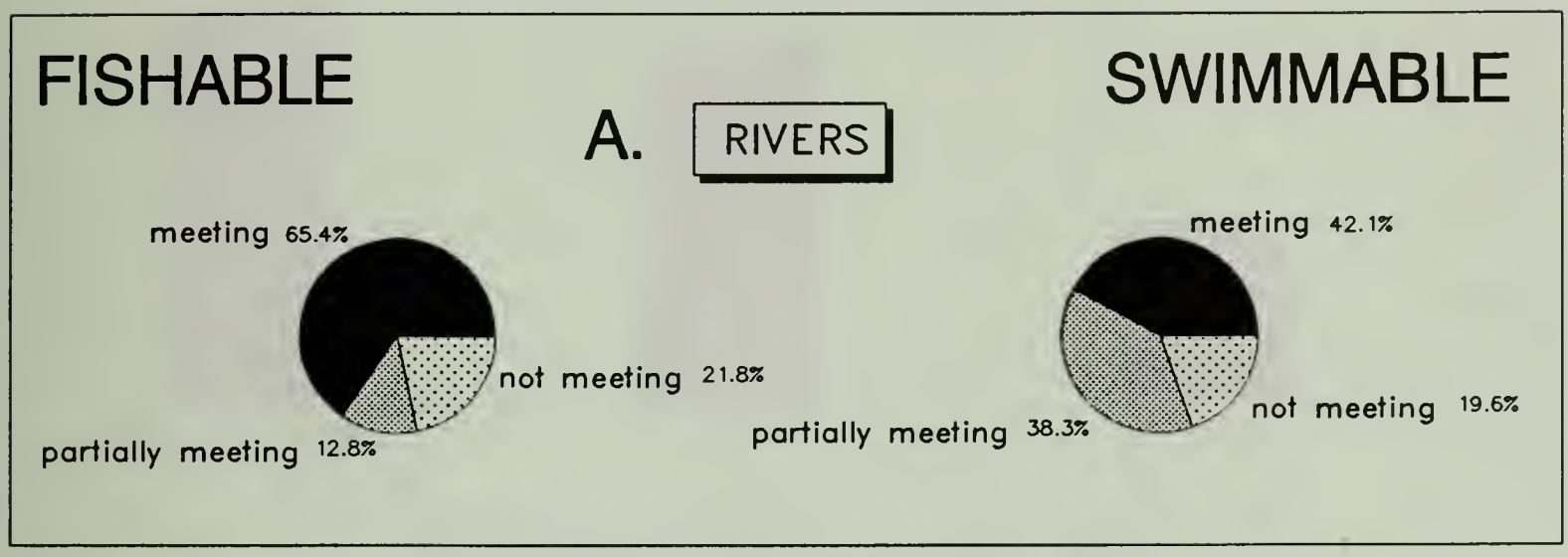
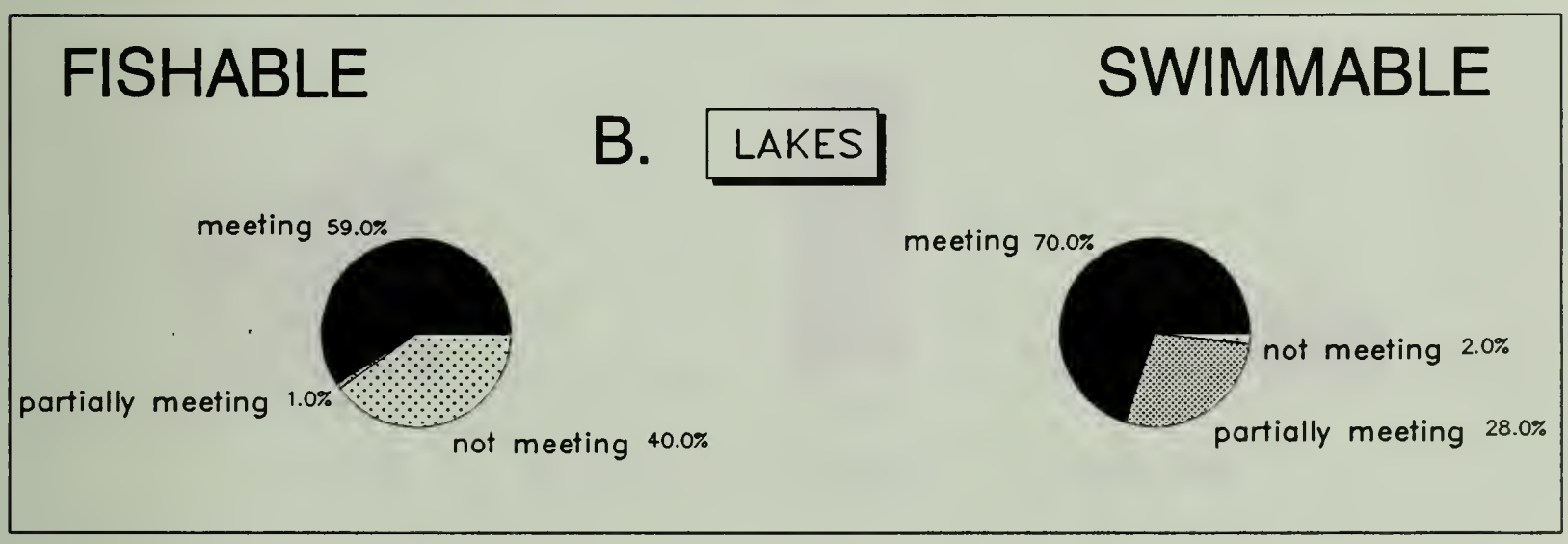


Figure 1.4

ATTAINMENT OF CWA GOALS
1989





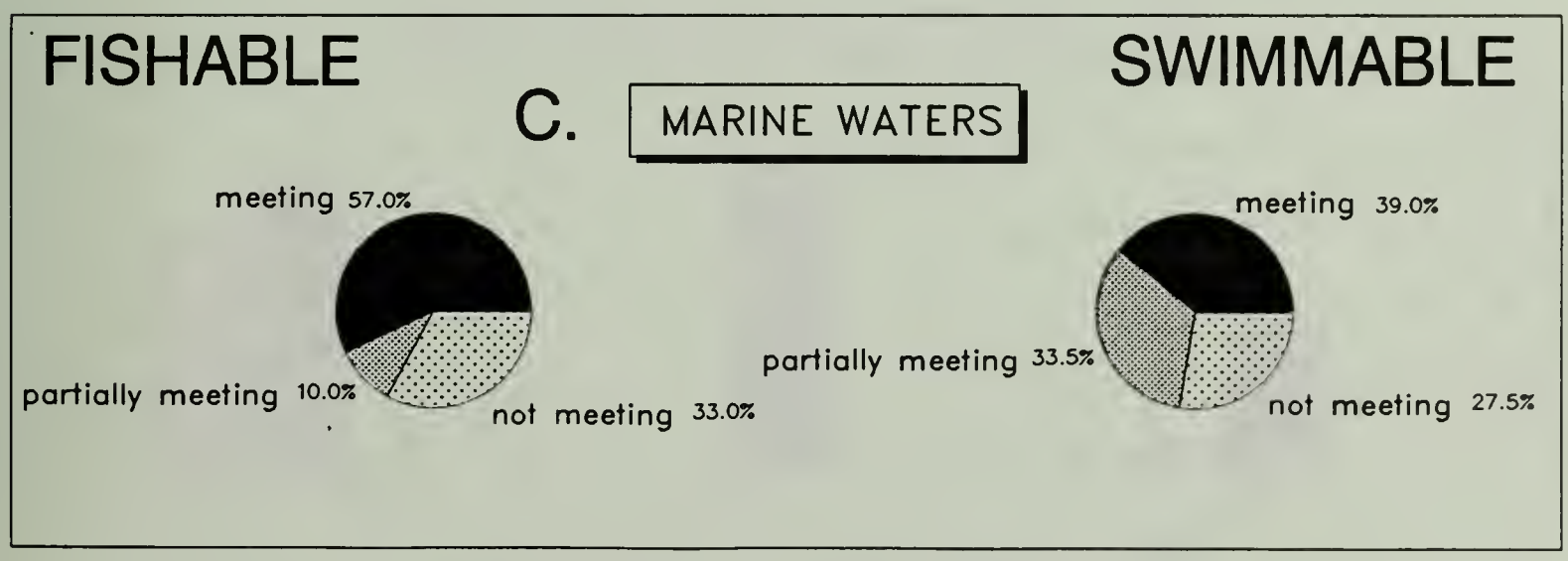
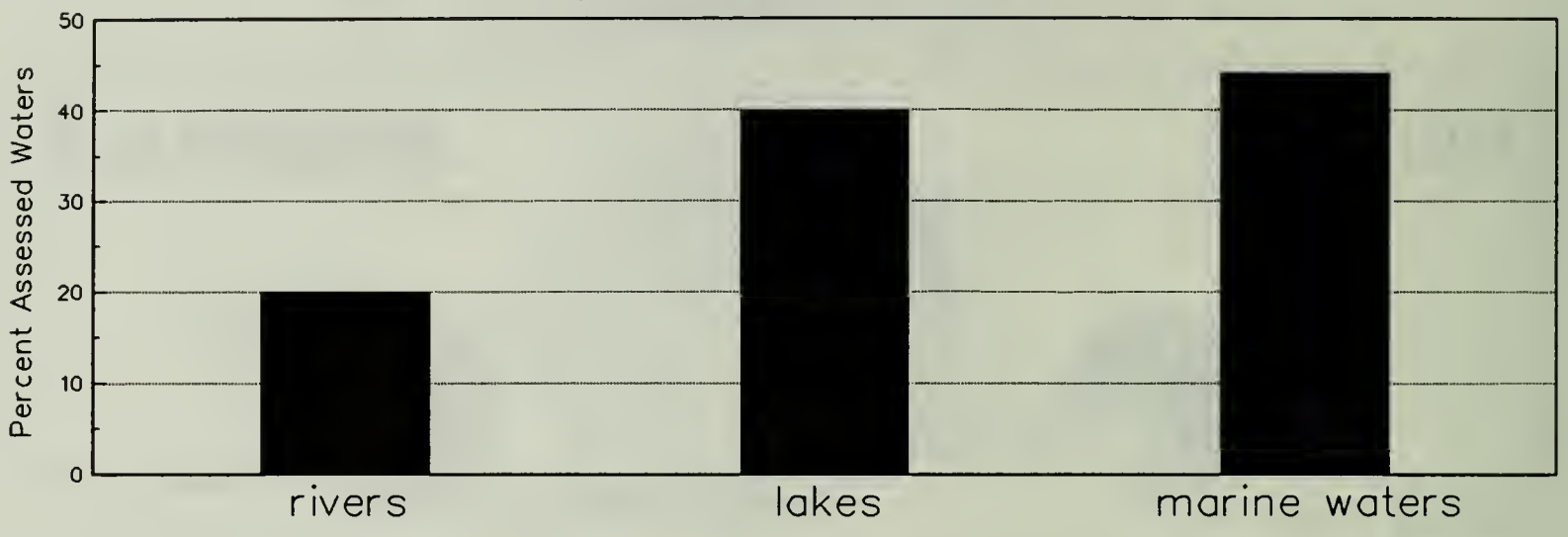


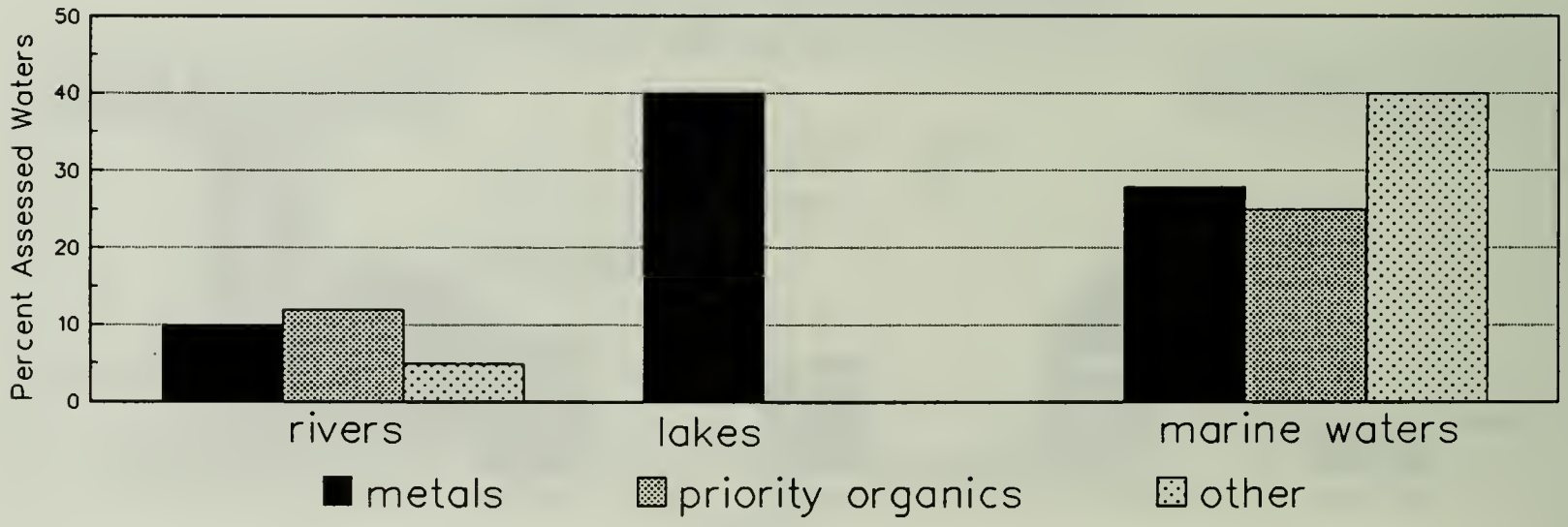
Figure 1.5

TOXIC ASSESSMENT IN SURFACE WATERS 1989

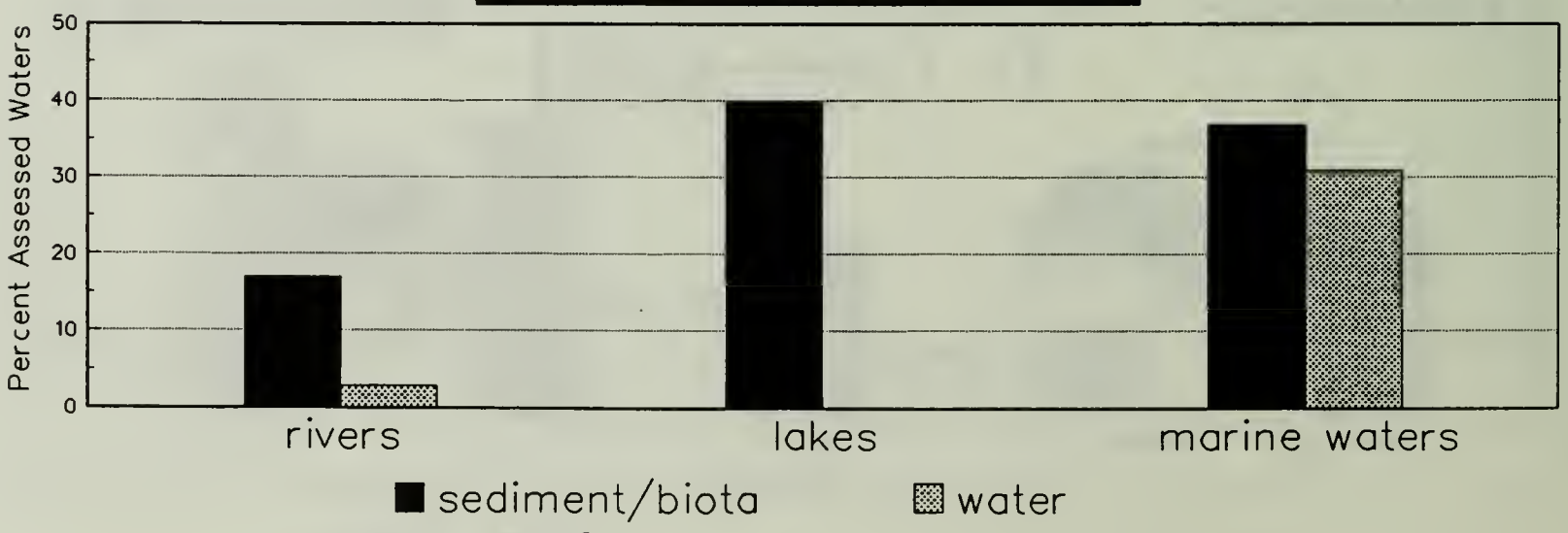
A. ELEVATED TOXICS



B. Causes of Non Attainment



C. Environmental Compartments



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